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# The Mysore Agricultural Journal

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# EDITORIAL

## SRI. M. VASUDEVA MURTHI, B.Ag.

We bid farewell to Sri. M. Vasudeva Murthi, B.Ag., Secretary, Mysore Agricultural and Experimental Union, who retired from service on 9th February 1956, after a long, devoted and dedicated period of service to the Department in general, and the Union in particular.

Born in Bangalore on 9th August 1900, he was educated at Madras, Dharwar and Poona. He graduated from the Poona Agricultural College in 1923 where he studied under such great savants of agriculture as Prof. Knight and Dr. W. B. Burns.

He joined the Mysore State Department of Agriculture in 1923 and taught at the Mysore Agricultural School, Hebbal. He was Secretary of the Mysore Agricultural and Experimental Union from 1939 to the day of his retirement and was also the Editor of the Kannada Edition of this Journal.

Sri. Murthi is a man of varied talents. He is a well-versed scholar in Urdu and Persian and has translated several classics of Firdausi, Saadi, Hafiz and Omar Kayyam. He has many elegant verses in Kannada to his credit and is a polished writer of Kannada prose. He has published more than eight books and several more works are awaiting publication. He is an active and untiring worker in the Kannada Literary Academy and represented this august body at several P.E.N. Conferences. Frail in body, unassuming in demeanour and self-effacing by temperament, he has boundless energy and enthusiasm. Under his stewardship the Union has gathered strength from year to year and when he retired, had on its roll more than 3,000 members, over 300 of them being Life-Members. Through great vicissitudes and difficulties in domestic and official life he has uncomplainingly kept a stiff upper lip and has dedicated all his time and labour for the Union and the Kannada Academy without expecting or getting any reward or extra remuneration. Such selflessness is a rare quality and if the meek do not inherit the plums of this earth they shall certainly inherit the affection and gratitude of countless companions and friends.

Sri. Murthi, even after retirement, was still hard at work to make the Agricultural Seminar that came off in May a

great success. It was his conception and pet programme. He carries with him in his years of retirement, the good wishes of all the members of the Union and a host of colleagues in the Department.

---

## GUSTAV HERMAN KRUMBIEGEL

We regret to record the death of G. H. Krumbiegel, Retired Director of Agriculture, in his 91st year in February of this year.

Krumbiegel was born in Germany on 18th December 1865. After his education at Willsdruff and Dresden and apprenticeship in various horticultural establishments in his native country, he was appointed in the propagation section of the Royal Botanic Gardens at Kew in 1888.

He came to India in 1893 as the Superintendent of the Gaekwar's Gardens at Baroda. In 1908 he came over to Mysore succeeding John Cameron as Superintendent, Government Gardens, and directed the Department of Horticulture till his retirement in 1932. During the absence of Dr. Coleman on long leave he officiated as Director of Agriculture between 1925-27. After his retirement, he became the Consulting Architect to the Government of Mysore and until a few days before his death he was horticultural and architectural adviser to several state governments and institutions. His contributions to horticulture, town planning and architecture in Mysore State are many and famous. The people of Mysore are grateful to him for the gracious gardens he designed in Brindavan, Mysore, and many other places all over the State.

Guest Editorial by M. Dwarakanath Sharma,
*Editor, "Lalbaugh".*

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## GREETINGS

We greet the new horticulral quarterly, *"Lalbaugh"* published by the Mysore Horticultural Society under the editorship of Sri. M. Dwarakanath Sharma and Dr. T. K. Dayalu. Mysore State is among the pioneers of horticulture in India and the two Horti-

cultural Shows the Society organises in February and August are unique in many respects. Nowhere in this country do we find such variety and excellence of exhibits as are staged in the Bangalore Shows. It is, therefore, but fitting that the Society which has done so much for the promotion of horticulture should launch a journal which has come none too soon and will be welcomed by all garden lovers in this State, particularly by those who are interested in floriculture.

We wish the journal all success and congratulate the Editors on the high standards they have set themselves in their first number.

# EDITORIAL ARTICLES

## PRELIMINARY TRIALS WITH CERTAIN INSECTICIDES AGAINST PADDY STEM-BORER, *SCHŒNOBIUS INCERTELLUS* WLK.

### Part I

By Dr. M. Puttarudriah[1] and M. Appanna[2]

Paddy stem-borer, *Schœnobius incertellus* Wlk., is the most common pest of paddy, its appearance having been recorded in all tracts where the crop is grown. The incidence of the insect varies from place to place as well from season to season. Whatever may be the incidence of the pest, the damage caused by it is very characteristic and draws the attention of any common cultivator. It has been observed that usually paddy grown in the season is less damaged than that grown later in the season.

The lepidopterous pyralid moth lays eggs in clusters which are covered by buff hairs; the larva, on hatching, bores into the stem and feeds within; it pupates inside the stem and the moth emerges through the hole cut in the stem. It is observed that there are two periods during the paddy season when the moths are seen in sufficiently large numbers and it can be inferred that the insect passes two generations in one season of the crop (Puttarudriah, 1945).

The control of paddy stem-borer is engaging the attention of several workers and various methods of control are either practised or suggested. Most of the control measures are mechanical in that efforts are put in to reduce the number either by attracting the moths to light traps or collecting and destroying the egg masses as also stubbles after harvest; DDT and BHC have been tried with limited success. In the past few years, several proprietary firms have put into market different insecticides advocating their use against paddy stem-borer.

Some of the chemicals were used for certain trials against the paddy stem-borer and this paper deals with the observations made thereon.

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[1] Government Entomologist, Division of Entomology, Department of Agriculture, Bangalore.

[2] Senior Assistant Entomologist, Division of Entomology, Department of Agriculture, Bangalore.

### Chemicals

(1) GEIGY SPECIAL G. 24525.—A proprietary product supplied by Geigy Insecticides, Ltd., Bombay, in a concentrated liquid form; a parathion compound, this chemical emits a strong odour causing a peculiar feeling of uneasiness; the Company advises not to inhale it at close range and also to effect dilutions in the open only.

(2) GEIGY WETTABLE POWDER.—Supplied by the same Company as above, this insecticide possesses a tolerable yet caustic odour; it forms a ready water suspension spray.

(3) FOLIDOL E 605.—A product of Farbenfabriken Bayer, Leverkusen, Germany, it is diethyl paranitrophenyl thiosulphate 46·6%, the rest emulsifier, an organophosphorous compound; it is said to possess a wide range of insecticidal value with penetrating effect into plant tissue. This product is also available in powder form at 1·5% concentration. Kisabu Iyatomi (1954) has reported that in potted plant experiments, FOLIDOL E 605 at 0·05% gave decided kill of the borer larvæ in paddy plants. The Government Entomologist, Coimbatore, has also stated that FOLIDOL E 605 at 0·025% gave encouraging results against paddy stem-borer. The authors (1955) have observed that FOLIDOL E 605 at 0·025 and 0·05% showed a penetrating action by killing paddy stem-borer larvæ inside stems.

(4) CHLOROTHION.—A product of the same firm as above. It is an organophosphorous compound said to be less toxic to man than FOLIDOL E 605, but equally effective as FOLIDOL E 605 against insects.

(5) *Endrin.*—A product of Messrs. Julius Hyman Co., U.S.A., was obtained from Messrs. Burmah-Shell Co., contains 19·5% Endrin emulsifiable concentrate. It is a chlorinated naphthalene compound said to possess a wide range of insecticidal value with good residual effect. Messrs. Burmah-Shell Co., have reported that insect control was more or less complete in the Endrin treated paddy plots and that the residual control lasted for 3 weeks.

(6) *BHC* 50%.—Benzene hexachloride—a commonly used insecticide.

### Precautions

The general principle of not bringing any of the above chemicals into contact with open wounds; not to chew betel

leaves or take any other eatables when handling these chemicals; and not to inhale the concentrates directly, was strictly adhered to whenever these chemicals were used.

### Object

The manufacturers suggest the use of their respective chemicals against the paddy stem-borer when the insect is found in large numbers either in its adult stage or in its egg stage. The application of the chemical at the proper time is qualified by a study of the incidence of the pest either directly when the crop is young or through the installation of light traps when the crop is grown up.

The main object of the trials was to find out the effectiveness of the chemicals on the borer larvæ inside the stem as also on the developing eggs and newly hatched out larvæ. Since the main object was to assess the effectiveness of the chemicals as mentioned above, efforts were not made to study the relative yields obtained in different treatments. Nevertheless, general observations on the after-effects of the different treatments were made.

### Material and Method

The main problem that confronted us in the conduct of the trials was the availability of suitable paddy plots with good percentage of infestation; in addition, the age of the crop also was a factor to be reckoned. As far as possible, crop of almost identically same age was selected for field tests.

The trials were conducted in the *ryots'* fields as well as in specially laid out plots both in the laboratory and on the Agricultural Research Station. In the *ryots'* fields, the area treated was determined in relation to intensity of attack by the pest so as to get on an average of about 30-50 'dead-hearts' in the young crop and the like number of chaffy earheads in the older crop.

Laboratory experimental plots were 3′ by 3′ and were planted with paddy seedlings in 5 rows with 5 plants in each row. After they were well established, the plants were artificially inoculated with paddy stem-borer egg masses for the larvæ to hatch and bore into the plants. Newly-hatched larvæ were also introduced on to the plants. The chemicals were sprayed on to the plants after 'dead hearts' made their appearance thus ensuring infestation and again in another lot when chaffy earheads made their appearance. The percentage of mortality was calculated on the actual number of larvæ found

inside the treated plants which were uprooted after a definite interval of time after spray and the number of larvæ that were found dead. This was considered to be the straight method of assessing the penetrating quality or the deep-seated action of the chemical. In the field tests on the Agricultural Research Station, statistically replicated plots, each measuring 5·5 cents, were laid out. In all, there were five replications. The crop was allowed to be infested naturally and to achieve this end, the plots were laid out in an area where a 12-15% infestation was observed on the surrounding crop.

The following chemicals were used :

(1) GEIGY SPECIAL No. G. 24525.
(2) GEIGY WETTABLE POWDER.
(3) CHLOROTHION.
(4) FOLIDOL E 605.
(5) FOLIDOL Dust.
(6) Endrin.
(7) BHC 50% Wettable Powder.

In all cases, water was used as diluent. The strengths were calculated on the basis of the rate of dilution keeping 1 lb. of the chemical in 100 lb. of water as 1% strength. A Sapperlot sprayer was used for spraying the plants. The treated plants were examined in 48 hours after treatment.

The following are the results of the trials :

(*a*) *In the* ryot's *field* :

Variety : S. 397 (Halubbalu) and S. 199 (Alur Sanna).
Locality : Yelahanka. Age of crop : 1-1½ months.

| Chemical | Strength | No. of dead-hearts | Total No. of larvæ | No. of larvæ alive | No. of larvæ dead | Per-centage of kill | Remarks |
|---|---|---|---|---|---|---|---|
| | % | | | | | | |
| FOLIDOL .. | 0·05 | 39 | 14 | 2 | 12 | 85·7 | |
| FOLIDOL .. | 1·5 | 50 | 14 | 2 | 12 | 85·7 | |
| FOLIDOL .. | 0·1 | 50 | 22 | 4 | 18 | 81·8 | |
| Endrin .. | 0·32 | 31 | 15 | 1 | 14 | 93·3 | |
| GEIGY SPECIAL .. | 0·17 | 32 | 10 | .. | 10 | 100·0 | |
| GEIGY WETTABLE .. | 1·6 | 36 | 6 | .. | 6 | 100·0 | |
| BHC 50% Wettable Powder.. | 0·8 | 50 | 10 | 6 | 4 | 40·0 | |
| Control (untreated) .. | .. | 50 | 22 | 16 | 6 | 21·4 | |

(*b*) *In the* ryot's *field* :

Variety : S. 1092 (Bangarkovi) and S. 199. Locality : Yelahanka.
Age of crop : 3½ months.

| Chemical | Strength | No. of dead hearts | Total No. of larvæ | No. of larvæ alive | No. of larvæ dead | Percentage of kill | Remarks |
|---|---|---|---|---|---|---|---|
| | % | | | | | | |
| FOLIDOL .. | 0·05 | 50 | 49 | 1 | 48 | 98·0 | |
| CHLOROTHION .. | 0·77 | 50 | 24 | 7 | 17 | 70·9 | |
| FOLIDOL Dust .. | 1·5 | 50 | 26 | 21 | 5 | 19·2 | |
| GEIGY WETTABLE .. | 1·6 | 50 | 20 | 9 | 11 | 55·0 | |
| GEIGY SPECIAL .. | 0·17 | 50 | 23 | 14 | 9 | 39·1 | |
| Endrin .. | 0·32 | 50 | 22 | 9 | 13 | 59·0 | |
| BHC 50% Wettable Powder .. | 0·8 | 50 | 22 | 19 | 3 | 13·6 | |
| Control (untreated) .. | .. | 50 | 24 | 20 | 4 | 16·6 | |

*N.B.*—Larvæ were observed just at the base of the earheads or one node below it.

LABORATORY TEST

Variety : S. 1092. Age of Crop : 1½ months.

In this series each treatment was replicated thrice, the total number of infested plants in all the three plots for each treatment was grouped together and counted as a single unit. On account of artificial inoculation, invariably more than one borer larvæ was found inside each affected plant.

| Chemical | Strength | No. of plants | Total No. of larvæ | No. of larvæ alive | No. of larvæ dead | Percentage of kill | Average |
|---|---|---|---|---|---|---|---|
| | % | | | | | | |
| FOLIDOL .. | 0·025 | 8 | 17 | .. | 17 | 100 | 100 |
| ,, .. | .. | 10 | 41 | .. | 41 | 100 | .. |
| ,, .. | 0·05 | 8 | 12 | .. | 12 | 100 | .. |
| GEIGY SPECIAL .. | 0·17 | 5 | 5 | 1 | 4 | 80 | 71·0 |
| ,, | .. | 4 | 37 | 14 | 23 | 62·1 | |
| Endrin .. | 0·32 | 5 | 12 | 7 | 5 | 41·6 | 51·6 |
| ,, | .. | 6 | 23 | 9 | 14 | 60·7 | |
| GEIGY WETTABLE .. | 1·6 | 3 | 8 | .. | 8 | 100 | 100 |
| ,, | .. | 2 | 13 | .. | 13 | 100 | |
| FOLIDOL Dust .. | 1·5 | 3 | 24 | 19 | 5 | 20·8 | 20·8 |
| Control (untreated) .. | .. | 8 | 26 | 26 | .. | .. | .. |

*In the Government Farm:*

Paddy plots, each measuring 1 cent. in extent, were laid out on the Agricultural Research Station, Mandya. The plots were statistically laid out with 5 replications as follows:—

| | | | | | | |
|---|---|---|---|---|---|---|
| G | A | D | F | B | C | E |
| C | F | A | G | D | E | B |
| E | D | G | C | A | B | F |
| B | A | C | E | F | D | G |
| P | B | E | A | C | G | D |

The treatment was given when the crop was a month-and-a-half old. The results obtained are tabulated below:

| Treatment | Total No. of plants | Total No. of larvæ | No. of larvæ alive | No. of larvæ dead | Percentage of kill | Average |
|---|---|---|---|---|---|---|
| A | 29 | 19 | 10 | 9 | 47·3 | |
| | 24 | 16 | 8 | 8 | 60·0 | |
| GEIGY SPECIAL | 26 | 17 | 9 | 8 | 47·0 | |
| No. G. 24525 | 30 | 20 | 11 | 9 | 45·0 | |
| 0·17% | 22 | 12 | 7 | 5 | 41·8 | 48·2 |
| B | 26 | 16 | 10 | 6 | 37·5 | |
| | 21 | 12 | 6 | 6 | 50·0 | |
| GEIGY WETT- | 40 | 27 | 24 | 3 | 11·1 | |
| ABLE 1·6% | 27 | 15 | 11 | 4 | 26·6 | |
| | 27 | 21 | 15 | 6 | 28·5 | 30·7 |
| C | 23 | 11 | 6 | 5 | 45·4 | |
| | 15 | 10 | 7 | 3 | 30·0 | |
| CHLOROTHION | 26 | 20 | 13 | 7 | 35·0 | |
| 0·77% | 24 | 12 | 7 | 5 | 41·6 | |
| | 28 | 13 | 9 | 4 | 30·7 | 36·5 |
| D | 36 | 26 | 3 | 23 | 87·6 | |
| | 27 | 18 | 2 | 16 | 91·2 | |
| FOLIDOL | 31 | 25 | 3 | 22 | 89·7 | |
| 0·03% | 32 | 28 | 3 | 25 | 88·5 | |
| | 31 | 15 | 1 | 14 | 92·3 | 89·8 |
| E | 30 | 21 | 2 | 19 | 98·1 | |
| | 31 | 16 | 1 | 15 | 90·6 | |
| FOLIDOL | 35 | 22 | 2 | 20 | 87·1 | |
| 0·06% | 34 | 18 | 3 | 15 | 86·2 | |
| | 31 | 15 | 1 | 14 | 84·3 | 89·2 |
| F | 32 | 17 | 10 | 7 | 41·1 | |
| | 24 | 11 | 6 | 5 | 45·4 | |
| Endrin 0·32% | 26 | 21 | 17 | 4 | 19·0 | |
| | 30 | 21 | 14 | 7 | 33·3 | |
| | 28 | 17 | 8 | 9 | 52·9 | 38·3 |
| G | 33 | 23 | 22 | 1 struggling | 2·3 | |
| Control | 39 | 28 | 27 | 1 struggling | 1·0 | |
| Sprayed | 30 | 25 | 24 | 1 struggling | 4·2 | |
| Water | 31 | 15 | 14 | 1 struggling | 3·5 | 2·2 |

In another series, 4½ months' old crop was sprayed. Observations made after 48 hours are recorded below :

| Treatment | Total No. of plants | Total No. of larvæ | No. of larvæ alive | No. of larvæ dead | Percentage of kill | Average |
|---|---|---|---|---|---|---|
| A | 30 | 24 | 23 | 1 | 4·1 | |
| | 34 | 19 | 18 | 1 | 5·2 | |
| GEIGY SPECIAL | 45 | 29 | 29 | .. | .. | |
| No. G. 24525 | 35 | 17 | 17 | .. | .. | |
| 0·17% | 33 | 29 | 23 | 6 | 20·6 | 5·9 |
| B | 37 | 28 | 18 | 10 | 35·7 | |
| | 37 | 24 | 22 | 2 | 8·2 | |
| GEIGY WETT- | 50 | 32 | 19 | 13 | 40·6 | |
| ABLE POWDER | 55 | 21 | 16 | 5 | 23·7 | |
| 1·6% | 36 | 25 | 22 | 3 | 12·0 | 24·0 |
| C | 29 | 12 | 7 | 5 | 41·6 | |
| | 39 | 22 | 16 | 6 | 27·2 | |
| CHLOROTHION | 45 | 26 | 15 | 11 | 42·3 | |
| 0·77% | 37 | 26 | 14 | 12 | 45·3 | |
| | 35 | 14 | 11 | 3 | 21·4 | 35·5 |
| D | 57 | 25 | 16 | 9 | 36·0 | |
| | 38 | 22 | 20 | 2 | 9·9 | |
| FOLIDOL | 45 | 31 | 22 | 10 | 32·2 | |
| 0·03% | 40 | 30 | 9 | 21 | 70·0 | |
| | 40 | 22 | 8 | 14 | 63·6 | 42·3 |
| E | 48 | 18 | 7 | 11 | 61·1 | |
| | 49 | 22 | 13 | 9 | 40·9 | |
| FOLIDOL | 34 | 23 | 14 | 9 | 39·1 | |
| 0·06% | 39 | 13 | 11 | 2 | 16·1 | |
| | 46 | 35 | 18 | 17 | 48·8 | 41·2 |
| F | 39 | 30 | 30 | .. | .. | |
| | 29 | 14 | 8 | 6 | 42·8 | |
| Endrin 0·32% | 39 | 15 | 15 | .. | .. | |
| | 39 | 17 | 17 | .. | .. | |
| | 29 | 17 | 16 | 1 | 6·4 | 9·8 |
| G | 25 | 10 | 10 | .. | .. | |
| | 36 | 22 | 21 | 1 | 4·5 | |
| Control Sprayed | 19 | 6 | 6 | .. | .. | |
| Water | 31 | 10 | 10 | .. | .. | |
| | 33 | 19 | 19 | .. | .. | 0·9 |

*N.B.*—In this series the borer larvæ were invariably found towards the base of the plants.

In another series of trials, the chemicals were tried at a stage when chaffy earhead were observed in the plots which were artificially inoculated in the laboratory compound. The number of larvæ in each plant was invariably more than one due to artificial inoculation.

The results of observations are recorded below :

| Chemical | Strength | No. of plants examined | Total No. of larvæ | No. of larvæ alive | No. of larvæ dead | Percentage of kill |
|---|---|---|---|---|---|---|
| | % | | | | | |
| FOLIDOL | 0·025 | 18 | 58 | .. | 58 | 100 |
| FOLIDOL | 0·05 | 24 | 72 | 6 | 66 | 91·6 |
| GEIGY SPECIAL | 0·17 | 9 | 12 | 5 | 7 | 58·3 |
| Endrin | 0·32 | 11 | 25 | 16 | 9 | 36 |
| GEIGY WETTABLE | 1·6 | 5 | 11 | .. | 11 | 100 |

## Discussion

From the data read above, it can be inferred that these chemicals have a toxic value on the borer larvæ inside the plant tissue, the degree of effectiveness varying with not only different insecticides but also with the age of the crop. There is seen a gradual reduction in the percentage of mortality of the borer larvæ in older plants when compared to that in young plants. This action of chemical might be only a deep-seated action, the chemical penetrating the plant tissue. In the controls which were run parallel to the treated plots, such phenomenon was not observed. Conditions being similar in the treated and the controlled plots the mortality of the borer larvæ in the treated ones may be attributed to the action of the chemicals. The larvæ in the treated stems were found mummified.

## Conclusions

All the chemicals did not show any phytotoxic effect in the dilutions in which they were tried. Treated plants looked more green and healthy.

The effectiveness of the chemicals on the adult moths, crabs, frogs and tadpoles in paddy plots was similar in that they were all found killed. Each was found to be as good as the other. BHC 50% also gave similar results except that frogs were not found dead.

The chemicals indicated different degrees of penetrating power or 'deep-seated acton' into the plant tissue and killing the borer larvæ within.

FOLIDOL E 605, CHLOROTHION, GEIGY SPECIAL, GEIGY WETTABLE POWDER and Endrin gave promising results on borer larvæ in young plants. On borer larvæ in older plants (plants with chaffy earheads) the effectiveness of the chemicals was variable. FOLIDOL E 605 proved better in killing the larvæ inside the stem.

The effect of the chemicals on older larvæ in stubbles or at the bases of plants was comparatively low in all the cases; of these, FOLIDOL E 605 gave a higher percentage of mortality of the borer larvæ.

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(Received : December 10, 1955)

# AMERICAN SORGHUMS IN MYSORE

By G. Srinivasa Iyengar and K. Gopala Iyengar*

These American jowars (*Sorghum vulgare*, Pers.) were introduced during the season 1947-48. Small-scale observation, and multiplication trials were undertaken on the Visvesvaraya Canal Farm, Mandya. It was observed that these varieties gave an economic return when sown during the *mungar* or *Kharif* season, *i.e.*, end of April or early in May. *Hain* sowings undertaken during June-July was found to be unsuited to these early varieties. The flowering and harvesting period coincided with heavy rains, and the crop was often badly damaged. Depredation by birds was also frequently severe prior to harvest. *Hingar* or *Rabi* trials on Babbur Farm served to demonstrate the fact that these varieties were poor in comparison with local ones. The outturn of both grain and stover was disproportionately low. Systematic field trials of these early, dwarf and double-dwarf varieties were undertaken since 1951. This preliminary note briefly summarizes the results obtained on the Visvesvaraya Canal Farm, near Mandya. Field trials included eight varieties along with local. A randomised replication layout was employed. Varietal differences were found to be significant for both grain and stover. Average performance of three seasons during 1951-54 was:

| Variety | Lb./acre | | Maturity | Colour of grain |
|---|---|---|---|---|
| | Grain | Stover* | | |
| Bonita .. | 1158 | 6854 | Very early | Dull chalky |
| Early Kalo .. | 1103 | 5397 | do | Rusty brown |
| Westland Milo .. | 1048 | 6387 | Medium early | Pinkish chalky |
| Martin .. | 955 | 6064 | do | Rusty brown |
| Norkan C.I. .. | 949 | 8110 | ,, late | Chalky cream |
| Plainsman .. | 926 | 5671 | Very early | Rusty brown |
| Pink Kaffir .. | 917 | 6429 | Medium early | Pinkish chalky |
| Early Higari .. | 854 | 7540 | do | Chalky cream |
| Local .. | 565 | 11016 | Late | Cream |

* Weighed at the time of harvest—not air-dry.

The local *jola* has a duration of approximately 4 months. The very early varieties will be ready for harvest, nearly 3 weeks earlier than local. Medium early varieties mature a

* Division of Economic Botany, Mysore State Dept. of Agriculture.

fortnight before the local and Norkan C.I., one week prior. The high yielding Bonita and Early Kalo, while being very early, suffer from a grain colour far from acceptable. Their outturn of stover, particularly of Early Kalo, is by far the lowest. Norkan C.I. has the highest outturn of stover and stands next to local.

In spite of these deficiencies, pilot trials in the districts have given rise to some demand for these varieties. Bonita, Early Kalo and Norkan C.I. appear to be worth further exhaustive trials. Many demonstration plots of Bonita and Pink Kaffir were laid out during 1953 in the District of Mysore. Yields of 4 to 5 *pallas* of grain per acre were secured (1 *palla* = 208 lb.). Stover outturn ranged from 1 to 3 cartloads. The highest yield obtained was 12·5 *pallas* per acre of Pink Kaffir near Chamarajanagar.

The illustrations have been furnished by Sri. P. R. Raghuram, the artist, and the demonstration trials were conducted in co-operation with the Assistant Director of Agriculture, Mysore, to whom thanks are due.

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*Left* : PLAINSMAN

*Right* : LOCAL

*Left :* BONITA

*Right :* PLAINSMAN

# SOME COMMON INSECT PESTS OF SUGARCANE IN THE VISVESVARAYA CANAL TRACT

By K. S. Shivashankar Sastry*

In Mysore State, sugarcane is an important cash and food crop and comprises an area of nearly 45,000 acres, of which two compact areas, each extending to 10,000 to 12,000 acres, are found in the V.C. Tract in Mandya District and the Tunga-Bhadra Project in Hospet, Bellary District. This crop is subject to the depradations of a number of insect pests, both major and minor, the latter sometimes assuming serious proportions under favourable conditions. It is intended in this note to give a short account of these pests, primarily from the V.C. Tract.

## Major Pests—The Sugarcane Seedling- or Stem-Borer

(*Chilotræ infuscatella* Sneller) (Pyralidæ, Lepidoptera).—This is a very serious pest of sugarcane. It is found almost all over the State and occurs throughout the year but is more abundant during January to April.

*Nature of Damage.*—The insect, in its larval stage, bores into the stem of the young plant and feeds on the internal contents, resulting in the death of the central shoot commonly known as a "dead heart". A newly sprouting seedling, if attacked, is completely killed. The presence of *dead hearts* in a cane field is a sure indication of the attack by this pest. Generally, the crop from 1 month to 2½ months old is preferred.

*Brief Life-History.*—Eggs are laid in overlapping clusters, generally on the first formed leaf-sheath or on the ventral side of the basal leaf-blades. The eggs are oval and flattened dorso-ventrally looking almost like the scales of a fish. They hatch in about 6 days. Just before hatching, the eggs look black with the almost formed larvæ enclosed in them. The newly-hatched larvæ reach the stem either by crawling or by hanging down by means of slender threads which they weave. The larva gets inside the first open sheath where it gets enough protection and then cuts a hole in the stem at the basal region and enters it. Here the larva grows feeding on the inner contents

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and causing the characteristic damage. A grown-up caterpillar measures about 1½" in length and is cylindrical, white, with dark brownish marks, hairs and tubercles ; head is dark brown. If the plant dries up or if food is not available, the larva moves out of such a plant to attack another. Pupation takes place in the stem. The adult moth is straw-coloured, with the palpi pointed forwards. It is nocturnal in habit and during the day, generally, takes refuge under the cane trash in the field. The life-cycle is completed in 35 to 40 days. Egg : 6 days ; larva : 20 to 25 days ; pupa 9 to 10 days.

*Natural Parasites.—Trichogramma minutum* Riley (Trichogrammidæ, Hymenoptera). This minute wasp is a very effective egg parasite in that it successfully parasitises the host eggs before damage is done. It completes its life-cycle within 8 to 10 days, and it has a number of generations in the year. A parasite breeding laboratory was established in Mandya in 1935—the first of its kind in India, and this parasite is being bred in millions on an alternate laboratory host, the rice moth *Corcyra cephalonica* St, (Pyralidæ. Lepidoptera) and released in the sugarcane fields on a very extensive scale both in the *ryots'* areas and in the Mysore Sugarcane Factory Farms in the V.C. Tract.

Other less common parasites include *Trichogramma japanicum* Ashm. and *Phanurus beneficiens* (Scelionidæ, Hymenoptera) on the eggs ; *Apanteles flavipes* Cameron (Braconidæ, Hymenoptera) and *Microbracon chinensis* Szpl. (Braconidæ, Hymenoptera) on the larvæ and *Sturmiopsis semiberbis* (Tachinidæ, Diptera) and *Tetrastichus ayyari* Rohwer (Eulophidæ, Hymenoptera) on pupæ.

Plant only borer-free cane setts : cane setts may be steeped in water for 72 hours to kill borers inside.

Earth up seedlings when 2 weeks and 4 weeks old and later when necessary.

Dust seedlings of same age with DDT or GAMMEXANE to cover the opening blades. Uproot the dead-heart-bearing seedlings and tillers and burn them.

Liberate egg parasites (*Trichogramma minutum*) in young cane fields.

Darkened egg masses may be collected wherever present and pinned on to leaf-blades of young cane where such eggs may not be present.

## The Top Shoot Borer

*Scirpophaga nivella* (Pyralinæ, Lepidoptera) is another major insect pest of sugarcane and occurs throughout the year. It prefers slightly grown-up cane, though also fairly common on young cane 1 to 1½ months old.

*Nature of Damage.*—The young larvæ begin feeding on the base of the central rolled up (cane) leaves and bore through the growing shoot. The attack, whether on young cane or on grown-up canes, is easily made out by the round circular holes on the leaf-whorl. As a result of damage to growing shoot, the side buds begin to develop and a *Bunchy Top* with a number of long green shoots is formed. Grown-up canes suffer mostly by the attack of these borers.

*Brief Life-History.*—Flattened scaly oval eggs are laid on the undersurface of the leaf-blades in clusters (7 to 40 eggs) which are covered with brown glistening hairs derived from the anal tuft of the mother. The eggs hatch in 8 to 9 days. The just-hatched larva is active, light brown with a black head. It gets disbursed either by the slender thread by which it hangs or by crawling on to the adjacent plants. It enters the plant at the base of leaf-whorls by making small punctures and tunnels into the midrib of the leaves and enters the stem to feed on the contents. When the larva is full grown, it is cylindrical, pale yellow in colour ; 25 to 35 mm. long. Just prior to pupation it cuts a hole on the wall of the tunnel and covers it with a thin membrane. The pupa is yellowish and is enclosed in a white thin silken cocoon. The adult moth emerges out of the exit hole. It is milk white in colour. The female is generally bigger in size and has a crimson-coloured anal tuft. The life-cycle occupies about 6 to 7 weeks in this case also.

*Natural Parasites.*—Two egg parasites, *viz.*, *Tetrastichus scirpophagæ* Mani (Eulophidæ, Hymenoptera) and *Phanurus beneficiens*, Zehtn. (Scelionidæ, Hymenoptera), are fairly abundant during certain seasons when they control the pest to some extent.

*Elasmus zehntneri*, *Stenobracon deesæ* and *Rhaconotus scirpophagæ* are common larval parasites. But their incidence is low.

*Tetrastichus ayyari* Rohwer (Enlophidæ, Hymenoptera) has been found to parasitise the pupæ in the laboratory.

*Control Measures.*—Systematically collect egg masses and moths in the cane fields.

Conserve the egg parasites obtained from the mechanically collected egg masses by releasing them back into the sugarcane fields.

Cut out borer-infested tops and destroy them. DDT (5%) dusting when cane is 3 months old or later is also recommended.

### Minor Pests

*The Cane Stem-Borer.—Proceras indicus* (= *Diatræa venosata* Kapur) (Pyralidæ, Lepidoptera). It occurs throughout Mysore State. It is similar in habits, life-history, etc., to *Chilotræa infuscatella*, but is more common on slightly grown-up cane.

### The Sugarcane Root-Borer

*Emmalocera depressella* Swinhœ (Pyralidæ, Lepidoptera). —This is a minor pest noticed only occasionally in Mysore State. It occurs throughout the year. The larva attacks and damages root stocks of sugarcane, both young and grown-up.

Eggs are small, oval and white. They are laid singly, rarely in clusters (2 to 12 eggs) on leaves, generally, sometimes on stem or soil. The newly-hatched larva crawls along the edge of the leaf and the stem to the ground level, at which point it enters the base of the shoot through some crack on the stem or between basal leaf-sheath and the stem and thus bores into the root stocks on which it feeds and damages. The fully-fed larva is greyish in colour with warts and hairs on the body. Pupation takes place at the ground level or just below it. The adult moth emerges through a circular hole or an exit tube constructed by the full-grown larva. It is straw-coloured with angles of upper wings curved. It is nocturnal in habit. The life-cycle occupies about 6 to 8 weeks.

### The Sugarcane Leaf-Hopper

*Dictyophara pallida* Don. (*Pyrilla perpusilla* Walker) (Fulgoridæ, Hemiptera).—This is a serious pest of sugarcane in Northern India (U.P., Bihar) and some of the cane-growing areas in South India (Madras and Hyderabad). Prior to 1951, it occurred in Mysore State only as a casual insect. However, during 1951 it was found in considerable numbers almost throughout the V.C. Tract. Since then, a careful watch is being

maintained on this potentially important pest and timely and effective control measures adopted at the very initial stages.

Both nymphs and adults occur in large numbers on the plants and suck up the sap which impairs the vigour and renders the plants sickly. The damage is more serious to young cane. Elliptical whitish eggs are laid on the under-surface of the leaf, near the midrib, in clusters, which are covered over by white silken filaments secreted by the mother. The eggs hatch in 7 to 8 days. Newly-hatched nymphs are white in colour with the characteristic tassels at the posterior end. For a while they congregate together and then disburse to other regions of the plant. The grown-up nymphs are ashy white in colour with bright red eyes and tassels. The adult is straw-coloured with a painted rostrum and has a blunt abdomen with a white mealy tuft at its extremity. Both the adults and nymphs are very active. They are more abundant during August-October. Besides cane, they are noted on *jola* and certain grasses.

The pest is effectively controlled by dusting the affected area with BHC (5 to 7%).

*Natural Parasites.*—Two egg parasites, *viz.*, (1) *Tetrastichus pyrillæ* (Eulophidæ, Hymenoptera), and (2) *Oencyrtus papiliorum* are generally found during August-September when they parasitise a fairly large number of host-eggs. A dryinid parasite attacks the grown-up nymphs occasionally.

### The Sugarcane Mealy-Bug

*Saccharicoccus sacchari* Ckll. (Coccidæ, Hemiptera).—The sugarcane mealy-bug has been a minor pest of cane in Mysore State. However, it was observed in considerable numbers during the drought period in 1950. It is pink in colour. The female is round, sac-like, the body being covered with a powdery mealy white secretion. It lays a large number of eggs, which hatch within a few hours and the crawlers migrate all over the plant and may often be blown off by wind from plant to plant. Heavy infestation results in stunted growth and often ultimately kills the plant. Infestation starts from the lower nodes, where colonies of adult bugs are found underneath the leaf-sheaths ; the crawlers migrate to the upper nodes. Infestation is heavy on the canes subjected to desiccation.

*Control.*—Setts may be steeped in water for nearly 48 hours before planting. Addition of paraffin or kerosene oil emulsion diluted to 30 times, or 40% nicotine sulphate (1 in 800 parts of

water) is also recommended. Heavily infested canes should be destroyed promptly.

*Parasites.—Anagyrus sacchoricola* Timberlake (Encyrtidæ, Hymenoptera) parasitizes the grown-up nymphs and adults and occurs in fairly large numbers during certain seasons.

### The Sugarcane Termite

*Odontotermes obesus* (Termitidæ, Isoptera).—The sugarcane termites occur in small numbers during April-May, but become sometimes serious in new clearings or when irrigation fails. In cases of severe attack, cane setts planted underground are badly damaged which often prevents germination, the setts and buds being completely eaten up and hollowed out.

Steep cane setts in a fairly thick solution of lead or calcium arsenate to give a coating, and dry the setts before planting wherever termite activity is noticed.

Collect dry twigs and leaves and place them in the furrows where termite activity is seen ; when the dry material is infested by termites, remove the whole lot and burn them.

Planting of arsenate-soaked setts may be done subsequent to this operation, specially in a new clearing.

Termite infested fields should be irrigated thoroughly and more frequently than in the case of uninfested fields. Any termite nests and mounds in the neighbourhood should be dug up and flooded or otherwise destroyed.

### The Sugarcane Mealy Wings or White Fly

*Neomaskellia bergii* Sigr. (Aleyrodidæ Hemiptera).—The sugarcane mealy wing is a minor pest which is highly localised in its distribution. It has been observed only in V.C. Farm, in considerable numbers, especially since 2 years. More recently it has been noticed in small numbers, in Keregod, and in Siruguppa, Bellary District. Both the adults and nymphs infest the leaves and suck up the sap which affects the vigour of the plants.

Small shining yellow eggs are laid in concentric semicircles on the under-surface of the leaf. The nymphs that hatch out after a period, adhere to the leaf-surface and feed and develop. On badly infested leaves, they and their dark mealy covered nymphal cases are found in thousands. The adult is a small, delicate insect specked with dark brown spots.

The pest can be controlled by cutting off the infested leaves in the initial stages and burning them.

### The Sugarcane Root Grub

*Holotrichia serrata* (Melonthidæ, Coleoptera).—Grubs of these beetle occasionally damage the roots. It is a minor pest.

*Control.*—Set up light traps soon after showers in summer to attract and kill the reddish adult beetles which emerge out from the grass lands in the neighbourhood.

Naphthalene or para-dichlorobenzene should be incorporated in the soil at a depth of 2-4" around cane clumps showing the withering effects due to the grubs and covered over well with a thicker layer of soil.

The following additional insects of minor importance have been noticed on sugarcane causing slight damage :

(*a*) *Stalk-Borers.—Chilo zonellus* Swinhœ and *Sesamia inferens* Walker.

(*b*) *Damaging Leaves.*—The tussock caterpillars (*Euproctis* Sp.); *Lassiocampid denodora vittata,* certain Jassids, the Fulgorid (*Assamia mœsta*), the paddy grasshopper (*Heiroglyphus banian*), the sugarcane hispa (*Asmangulia cuspidata*), certain scale insects and aphids and the mite (*Paratetranychus indicus*).

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# DRY FARMING IN MADRAS

By S. B. Priyavratha Rao*

## Introduction

Dry farming is the system of soil and crop management in regions of low and uncertain rainfall. Crops tend to fail often in these areas, resulting in frequent famines. Even in non-famine years, the crop production is low due to deficient rainfall. To improve the agriculture in these tracts, research was undertaken at Hagari (in Bellary District) with the financial assistance of the Indian Council of Agricultural Research. Hagari is a typical dry farming area, having the lowest annual rainfall (about 20") in the Madras State. The crop yields are also practically the lowest in the Presidency. The dry farming research at Hagari was conducted for 9 years (1934-35 to 1942-43) with twofold objectives. They were (*i*) to make a scientific study of the problems involved, and (*ii*) to suggest suitable solutions for the same. The experimental results achieved in the research scheme were tested in a developmental scheme for a period of 5 years (*i.e.*, from 1942-43 to 1947-48). The improvements suggested were tested in the cultivator's holdings, to know the practical difficulties involved, when applied on a large-scale and to observe the reaction of the ryots towards them. The items of research work done and the results achieved under the Dry Farming Scheme at Hagari are discussed in this paper.

The annual rainfall at Hagari is not only low but also uncertain and erratic in distribution. It varies from 11" to 23" per annum. The rains received during the hot weather period are of little use agronomically. *Mungari* rains are very uncertain and sowing of the *mungari* crops is a mere gamble with nature. More than half the total rainfall is received within a limited period of 5-6 weeks, in the months of September and October. As a rule, it is in these rains, that the success of the cropping of the whole year depends. The soils are of heavy black cotton type. They are slow to absorb rain-water. Cotton and jowar which are grown in rotation, form the important crops of this tract. *Setaria* (Italian millet ನವಣೆ ) is also grown as a mixture with cotton and as a pure crop to a certain extent. The

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tract is thinly populated and the cultivators are poor. The cultivation practices are simple, efficient and unique. There is scarcity of both human and cattle labour. Consequently, labour-saving implements and devices are largely in vogue. The implements in use are *Gorru* (six-tyned seed drill); *Guntaka* (the blade harrow) and *Danthi* (the small blade harrow). In short, the cultivation in general is of a ploughless type. Deep cultivation with a heavy plough is resorted to only in fields that are heavily infested with perennial weeds like *Hariali* (*Cynodon*). Normally, the land is worked with *guntaka* 3-4 times as preparatory cultivation. The crops are invariably sown with seed drills, in perfectly straight lines. The intercultivation is done with miniature *guntakas,* called *Danthis,* for removal of weeds and conservation of moisture by creating a loose soil mulch in between the rows of standing crops.

The main problems of the dry farming area in Bellary are as under: (*i*) to make the best use of the little rainfall for successful crop production; (*ii*) to increase the absorbing power of the black soils; (*iii*) to reduce the run-off of rain-water and check the consequent soil erosion; (*iv*) to raise the fertility status of soils; (*v*) to evolve drought-resistant and high-yielding strains, and (*vi*) to suggest cheap and more efficient cultural practices, and thus reduce the cost of cultivation without detriment to crop yields.

### Work Done in Dry Farming Research Scheme

The following fundamental problems were first studied in the dry farming research scheme at Hagari. The studies included (*a*) rainfall and seasons; (*b*) soil studies; (*c*) crop studies, and (*d*) agronomic investigations. The experimental findings are given below. The total rainfall is not only low but also highly variable from year to year. The distribution of rainfall is also uneven and highly erratic in nature. The soils are of the heavy black cotton type with a high clay content. They are slow to absorb water but are highly retentive of moisture. Soils crack deep and wide in summer, on account of shrinkage due to evaporation. Black soils are sticky when wet and hard when dry. They are poor in nitrogen and as well as in organic matter. They are also alkaline in nature. The soils swell enormously when wet and clog the pore-space and percolation is retarded, resulting in run-off. Experiments conducted in soils with 1 in 80 gradient, revealed that one-third to half of the rain-water was lost by run-off. Soil loss through erosion

was also noted. Every inch of run-off water carried away 1·5 tons of fertile silt per acre. Among the cultural methods tested to conserve moisture, bundformer-bunding proved very useful. Bunding allows the rain-water to stand on the field for a longer time, thus facilitating its greater absorption by the soil. Ploughing and addition of organic matter improved the physical texture of the top soil, which also helped in absorption of more rain-water. The moisture content of the soil in the second foot layer had a decisive effect on the crop yields. The quantity of soil moisture at the sowing time also influenced the crop yields considerably. In the breeding trials it was found, M. 47-3 jowar (Maldandi of Bombay) was eminently suited to the low rainfall conditions at Hagari. It is shorter in duration than H.1, by 15 days and gave better grain yields than H.1, even in low rainfall years. But, M. 47-3 was a poor straw yielder. Two high-yielding *Setaria* strains [*viz.*, K.23-(H.1)- and K.68-(H.2)] were isolated by pure line selection. Root studies of different crops revealed that roots of *Setaria* were thinner, finer and more profusely branched than the others. The short-duration Bombay jowar (M.47-3) produced more number of roots in the early stages than the local. Owing to the quicker development of roots and the more efficient root system, M. 47-3 was able to withstand the drought better than the locals. Soil conservation methods like bunding, fallowing, manuring, etc., resulted in better root development of plants. Groundnut crop had the highest anti-erosive value. *Setaria* stood second in order, while cotton and jowar (*Sorghum vulgare*) possessed very low values. Agronomic investigations revealed that bundformer-bunding as the most efficient and cheapest method of increasing crop yields. Bunded plots showed higher moisture content than the non-bunded areas. The increased moisture in the bunded plots has contributed towards higher yields. Bunded plots yielded Rs. 3-12-0 more net profit per acre, per annum, than the non-bunded areas. The scooping trials were not better than bunding but proved more costly. Spacing experiments revealed that 18″ for jowar and 36″ for cotton were more beneficial than the local spacings of 13½″ and 27″ respectively. In the interculture experiments, hand-weeding proved costly. Intercultivation with *Danthi* was cheap and also efficient. Fallowing proved to be unprofitable. Manurial experiments revealed that 6,000 lb. of cattle manure per acre, applied once in 3 years as the optimum dose. A combination of manuring and bunding gave the best results.

## Work Done in Dry Farming Development Scheme

The following improved dry farming practices evolved at Hagari were tried in the developmental scheme, on a large-scale, in the cultivator's holdings. They are: (1) Bundformer-bunding; (2) wide spacing of crops; (3) improved strains of crops; (4) manuring the fields; (5) contour cultivation. In addition, the utility of permanent field embankments were also tested in the *ryots'* holdings. The improved dry farming practices were tried with the common crops of the tract, over an area of 1,300 acres spread over five seasons. The results obtained were consistent and they are presented below.

Bundformer-bunding consisted of putting up small temporary bunds 6-7" high, with about 18" base with a bundformer. Five to ten cents[1] compartments were formed to trap rain-water and to make it stand on the land for a longer time. This resulted in additional amount of moisture, which is forced into the land without running to waste. Bunding was done as a final operation in the preparatory cultivation in June-July, so that the bunded compartments catch sufficient rain-water before the sowings. This kind of bunding cost 10-12 annas per acre. The increased yields due to bunding ranged from 11-18 per cent. over the non-bunded plots. The value of the increased produce was about Rs. 6 per acre at the then market rates. The local spacings for cotton and jowar were 27" and 13½" respectively. A wider spacing of crops, *viz.*, 36" and 18" for cotton and jowar respectively, proved to be beneficial. It was more so in years of low rainfall. It also resulted in saving of seeds and greater ease and quickness in cultivation. Among the jowar strains tested against H.1 (local), M.47-3 (a short-duration type from Bombay) which evades drought by ripening earlier, was found to be more useful, especially in low rainfall years. In normal years, H.1 gives as much grain as M.47-3, but it always gives higher straw yields. M.47-3 was found to be more suitable for shallow soils and H.1 for deep soils. Straw is equally important in this tract. Jowar is sown in October by which time most of the rainfall would have fallen. It is suggested to use the more suitable strain depending on the rainfall in a year, instead of always adopting one strain. Of the two improved strains of *Setaria*, H.1 (K.23) preferred lighter soils; while H.2 (K.68) fared well in the heavier soils. Both these improved

[1] 100 cents = 1 acre.

types recorded about 10 per cent. higher yields than the locals. Combination of bunding, improved strains, and wide spacing was tested to find out the best practice to be adopted. In the case of *jowar,* it was most profitable to adopt bundformer bunding and H.1, with a spacing of 18" between the lines; while the cotton plots have to be bunded and the lines spaced 36" apart. Strip-cropping trials were not much of a success, as the common crops raised in this tract possess low anti-erosive values. Erosion-resisting crops like trailing legumes and groundnut do not come up well in the heavy black soils. Hence, the value of strip-cropping has only a limited scope in this area. The problem of manuring in dry farming zones is difficult to solve. Bulky organic manures like cattle manure were found to be useful for such dry lands. The low rainfall does not provide enough soil moisture to make the manure readily available to the plants. The yield response to manuring will be more telling in normal and good rainfall years. During low rainfall years, the crop in the heavily manured fields sometimes gets scorched and dries up in patches. Cattle manure proved better than compost manure on equal nitrogen basis. Cattle are few and nearly half of cattle dung is burnt away as fuel. Fuel is scarce in the tract. Alternative fuel sources are to be made available to release the entire cattle dung for manurial purposes. Preparation of compost manure from village wastes should be encouraged to augment the manure supply. Contour cultivation offers resistance to the free movement of rain-water and checks erosion effectively. It is ideal to cultivate strictly on the contour. Under the existing conditions of small holdings, and general level of education of the cultivators being low, it is difficult to strictly enforce contour-cultivation. The next best method is to cultivate across the main slope of the land, irrespective of the field dimensions. Its advantages can be seen only in the long run and not immediately as in the case of manuring, bunding, etc.

Bundformer bunds are more useful in lands having gentle slopes of 0·5 per cent. and less. In higher slopes, permanent field embankments are necessary. Bunds are an insurance against famine. Cultivators do know that permanent embankments are a corrective to the low rainfall and soil erosion. But they are not aware of the correct type of bunding required for slopy lands. Several types of permanent field embankments were tested with a view to devise a cheap and suitable type and with a minimum change in the existing field boundaries, consistent

with efficiency. They are : (1) contour bunds with and without weirs; (2) field-border bunds; and (3) terrace bunds. Strict contour lines were marked and permanent bunds were formed after smoothening the sinuosity of the lines. In lands with 1 per cent. slope, the distance between the bunds was 300′. Bunds were formed with an 8′ base and 3′ in height, with and without waste-weirs. It was found that with heavy rains, there was much stagnation of water near the bund, for a long period, in bunded compartments without weirs. This retarded the cultivation operations. As the dry crops do not tolerate the standing water for a long time, the plants under water perished. Weirs facilitated the drainage of water and were also helpful in protecting the bunds from breaches during heavy rains. The crops were good right from bund to bund as the spread of water was more even. Thus, weirs were found to be absolutely necessary. Three kinds of weirs, *viz.*, masonry weirs, filter weirs, and concrete type weirs were studied. Of the three, the filter weir was very cheap and as well as efficient. Rectangular compartments with an area of 3-4 acres in extent were formed along the existing field boundaries. No weirs were provided. As this type of bund defined and protected the existing property lines, the cultivators first liked them much; but changed their opinion later; as this type of bunds proved to be the worst. The water spread was not uniform, consequently breaches were more frequent than in other types of bunds. They were also more costly to put up, because they consumed more length of bund per unit area enclosed. A model terrace bund enclosing a three-acre plot was put up and studied. The base width was 50′ and the height at centre was 2½′, sloping off in both the directions. It was both rat-proof and breach-proof. It can be put strictly on the contour without affecting the field boundaries and the bund portion also could be cultivated. Crops were good in the bunded area and as well as on the bunds. The main drawback was its cost. It was three times more costly than other types of contour bunds.

The land in the embanked areas became more even in the course of 3 or 4 years, as the old gullies and streamlets ceased to exist. Permanent embankments prevent the erosion of soil, help in conservation of more moisture and give increased crop yields. The yield differences were more spectacular in low rainfall years than in normal years. The increase in yields of jowar and cotton due to embankments alone, ranged from 16 to 30 per cent. Based on these findings, the Government of Madras sanctioned a contour bunding scheme in 1950 for large-scale

bunding in these arid areas. Three centres (*viz.*, Hagari, Alur and Guntakal) with 1,500-2,500 acre blocks as units were taken up for this work, and the work is in progress. In view of the poverty of the local *ryots*, the Government came forward not only to meet half the cost of the land improvement, but also to advance the entire sum required for the purpose and also undertake the execution of the work departmentally. The share of the cultivators' expenditure was treated as on loan without interest, which has to be redeemed in 20 equated annual instalments.

The advantages derived by the *ryots* in the districts of Bellary, Cuddapah and Anantapur, by adopting the improved dry farming practices, were estimated by the Departmental staff. During the year 1949-50 alone, the total increased yield obtained was nearly 8·79 thousand tons of foodgrains and the extra income valued amounted to the tune of Rs. 19½ lakhs. Therefore, the *ryots* are advised to adopt these improved dry farming practices with advantage.


## Summary

Fundamental problems like rainfall and seasons; nature of soils and their reaction to varied intensity of rains; crop response to different agronomical practices adapted to conserve soil moisture were studied in detail in the original research scheme. In the development scheme, the results achieved in the research scheme were put to test on a large scale in the cultivators' holdings to confirm the laboratory findings and also to study the reaction of the *ryots* to these improved practices.


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# NOTES ON THE PRELIMINARY EXPERIMENTS WITH CHEMICAL WEED KILLERS

By Dr. M. Puttarudriah*

In recent years, it has been the experience that the cost of cultivation is largely chargeable to weed control. Weed control in India has been mainly by manual labour; and chemical control has not made much headway in this regard; whereas, in Western countries, weedicides are even being sprayed by aeroplanes.

To explore the possibilities of chemical weed control and to work out the economics of this method and to study the factors like dosage, temperature and time of application, etc., preliminary tests were undertaken with some samples of weedicides—2, 4-D compounds of a selective and hormone type. Altogether nine samples, of which eight were selective and one general, were obtained from Messrs. A. Manual & Co., Ltd., Bombay; Farben Fabriken Bayer, Germany, through Chika Co., Ltd., Bombay; Imperial Chemical Industries of India, Madras; Rohm & Haas, America, through Ranya & Co., Bangalore; and Pest Control, Ltd., Cambridge, through Parry & Co., Madras. Thanks are due to these firms.

To get indications of the results, the samples were sprayed or dusted on small patches of wild weeds growing in the laboratory compound; the weeds so treated were *Acanthospermum hispidium; Euphorbia geniculata; E. hirta; Bidens pilosa; Alternanthera echinata; Croton sparsiflorus; Cyperus rotundus; Lantana camara; Centella asiatica; Heliotropium sp., Argemone mexicana* and *Ocimum canum,* all of which are common, and in some localities serious weeds met with in the fields.

## Weedicides Tested

(1) *Hedonal Powder.* A sodium salt of 2, 4-D was sprayed by a water-can at the rate of 8·8 oz. dissolved in 2·2 gallons of water on the above-mentioned weeds.

Within 24 hours, the plants showed a faded and bent appearance distinct from untreated plants. The noted effect was dropping of leaves; growth abnormalities like twisting of the stems,

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leaf-petoles, and reduced leaves at tips, all due to unco-ordinated growth and proliferation of cells. The leaf-margins became wavy. The scorched symptom was made out and the weeds were completely killed in 5-10 days ; the younger stages being killed quickly and the older ones late. This weedicide was tested on a large scale at Hebbal on *A. hispidum* and *C. sparsiflorus* and the laboratory indicative results were confirmed. *Cyperus rotundus* was killed in about a week.

(2) *Hedonal Liquid.* The amine salts of 2, 4-D acid was sprayed on the above weeds at the rate of 3 c.c. in 2 gallons of water. Though the same symptoms as in the case of HEDONAL powder appeared, complete kill of the weeds took 16 days; this was due to the fact that the weeds were all grown up and old plants.

Field tests at Hebbal, as in the case of the powder, confirmed the laboratory results.

Samples of these two weedicides were obtained from M/s. Farben Fabriken Bayer, Germany, through Chika, Ltd., Bombay.

(3) *Agroxone.* Ready to use dust methyl chlorophenoxy acetic acid was dusted at 1% and 5% respectively on the above weeds. Though from the literature, it is seen that this weedicide dust is effective in killing several weeds like striga, *Cyperus, Leucas, Lantana,* etc., repeated trials with it did not give complete kill on any of the weeds treated, except for a slight bend and reduction in the petioles. Four repetitions with the two strengths were made and the results were not satisfactory.

(4) *Fernoxone.* It is the sodium salt of 2, 4-D. The powder was dissolved at the rate of 20 oz. in 100 gallons of water and sprayed on the above weeds. The drooping effect on the leaves could be seen very quickly in about 2-3 hours and the lethal effect on all the weeds was obtained in 10-15 days.

Rain received after spraying on the plants retards the effect of the weedicide.

These two weedicides were obtained from M/s. Imperial Chemical Industries, Madras (India).

(5) *San D.* 50. Powdered spraying medium, consisting of technical sodium, 2, 4, dichlorobenoxyacetate 50%. It was dissolved at the rate of 8 g. in 781 c.c. of water (dose : 4-5 kg. per hectare) and sprayed on the above weeds. In about 10 days, the weeds were killed.

(6) *San K-M.* 30. Spraying medium in aqueous solution, consisting of technical amino salt, 4-chloro-2-methyphenoxy acetate 30%. Recommended dosage, 6-10 kg. per hectare. This liquid weedicide was diluted at the rate of 16·5 c.c. in 781 c.c. of water and sprayed on the above weeds. Within 24 hours, *E. geniculata* was completely killed as the plants were young. Even the other weeds were quickly affected and were dead in less than a week. The liquid medium was quicker in action than the dust solution.

These two weedicides were obtained from M/s. A. Manual & Co., Bombay.

(7) *Kathon M.* 7. Amino salt of 2, 4-D liquid medium. It was diluted at the rate of 35 c.c. in ½ gallon of water, and the dosage used per acre was 2 pints in 20 gallons of water. This is a powerful weedicide, and in spite of rains, these weeds were killed in 5 days.

These seven samples of weedicides were comparatively tested on the above-mentioned weeds. The effect was similar and good, the symptoms same, but the time taken for a complete kill of these weeds varied due to difference in the age and size of the weed plants ; and also due to washout by rains in some cases. Repeated tests gave the same indications. In all cases *E. geniculata* was the most susceptible and *A. echinata* took the longest time.

Other economic plants like castor, *jowar, Crotalaria* in the vicinity were badly affected.

(8) *Tributon.* Based on 2, 4-D and 2, 4, 5-T esters, for killing woody weeds. This non-selective general weedicide was sprayed on large bushes of lantana at the rate of 2 litres of the material in 300 litres of water. The quantity used for spray in this test was 31 c.c. in 1 gallon of water. The effect was very good ; the lantana bushes were done to death in about two weeks. Even parts of other plants like the jak- (*Artocarpus integra*) custard, apple, etc., were scorched up. This is a very good general weed killer for woody weeds in the forest lands and roadside weeds, etc. It was also sprayed on *Cynodon dactylon* and found to be effective but the action is delayed and a stronger formulation is required. Tributon was also found to kill *Aristolochia bracteata,* a bad weed in cotton fields. This can be recommended for spraying on very young *Aristolochia* plants, before cotton seeds are sown.

(9) *Phenoxylene* 30. A harmone type chemical, which is the sodium salt of MCPA (Methylchlor-phenoxyacetic acid). This, along with the seven above-mentioned selective weedicides, were taken up for tests on weeds grown in paddy plots, to study and be sure of the effect of these chemicals not only on the weeds but also on the blades of paddy and ragi.

Nine plots of equal size, 5′ × 5′, were laid out for paddy and ragi separately and seedlings were transplanted. Along with them, young weed plants collected from paddy fields in the nearby villages were also planted between the rows of paddy and ragi seedlings.

The weeds were: *Euphorbia geniculata, Sphæranthus indicus, Sesbania paludosa, Argemone mexicana, Commelina bengalensis, Cyperus rotundus, Ageratum conizoides, Mollugo cerviana, Acanthospermum hispidum, Chenopodium album, Eclipta alba, Asteracantha longifolia, Cyanotis axillaris, Cynodon dactylon, Achyranthes aspera, Leucas aspera, Cucumis sativus, Celosia argentia, Physalis minima, Oxalis corniculata,* and *Amaranthus spinosus.*

Care was taken to have all these types of weeds in each of the nine plots for getting comparative idea of the effect of the several weedicides on them and also on the cereal plants themselves. Observations were recorded every day for the effect of the weedicides on the plants. Eight plots were treated and one was maintained as untreated check. All the weedicide samples except TRIBUTON were used at the same formulations as in the indicator tests.

The usual drooping and twisting symptoms of the leaves and stems were noted on the weeds, except in *Cynodon dactylon.* Again *E. geniculata* was the earliest to succumb in all the tests. But AGROXONE dust had no effect on other weeds. In about a week the dicot weeds, and the nutgrass, *Cyperus rotundus,* too were bent and twisted ; but the paddy and ragi blades also showed an yellowish tinge at the margins. In about 20-25 days the paddy and ragi blades improved in colour except in the case of HEDONAL powder. The final observations were recorded after six weeks.

AGROXONE dust had no effect on the weeds but the paddy and ragi stands were good. All the other weedicides had completely killed the weed plants leaving a good stand of the

cereal plants; but in the case of HEDONAL powder and liquid and KATHON M. 7, the blades of paddy and also ragi showed scorched spots and general yellowing. The plants did not improve in colour and they gradually faded, the crop stand being poor when compared to other plots. Phenoxylene was found to be the best of the eight samples as it gave a satisfactory kill of the weeds without affecting the crops in any way.

Two more repetitions were conducted in the same way and the observations were corroborated.

One more test was conducted by sowing the paddy seeds, first in water for two days and then for 15 minutes in each of the eight samples and then sowing in separate plots. The germination failed in all the cases, except that it was delayed and 50% in HEDONAL liquid and phenoxylene.

In conclusion, from the results noted in the indicator as well as plot tests, it may be stated that these weedicides are effective on dicot, broad-leaved weeds and the nutgrass, but not on *Cynodon* and other grasses. TRIBUTON, a general weed-killer, can be used in killing these grasses. But these weedicides cannot be used in ragi and other dry crop fields as many economic inter-crops like *cajanus, lablab,* castor, *jowar,* cow-pea, etc., are grown ; even the slightest drift of these chemicals while spraying or dusting has been found to kill them. These weedicides will be useful in controlling weeds in paddy plots, but experiments are necessary to find out the proper time, and age of the weeds for using them. They are all harmful chemicals to human beings and animals ; and so adequate protection is necessary to operators and also economic plants.

These studies are being pursued. Most of the weed plants* mentioned in these tests were identified by Sri. H. C. Govindu, Senior Lecturer in Botany, Mysore Agricultural College ; and thanks are due to him.

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* Kannada equivalents of the weeds mentioned in the article are listed below.—*Ed.*

1. *Acanthospermum hispidum*—ಕಡಲೆಮುಳ್ಳು, ಮುಳ್ಳು ಬೀಜದಗಿಡ
2. *Achyranthes aspera*—ಉತ್ತರಾಣಿ
3. *Ageratum conizoides*—ಊರಾಳಗಿಡ
4. *Alternanthera echinata,* Kaki weed—ಮುಳ್ಳು ಹೊನಗನ್ನೆ
5. *Amaranthus spinosus*—ಮುಳ್ಳುಕೀರೆ, ಮುಳ್ಳುಹರಿವೆ
6. *Argemone mexicana,* Mexican Poppy—ದತ್ತೂರಿ

7. *Aristolochia bracteata*—ಕತ್ತೆಕಿರುಬನಗಿಡ, ಕುರಿಗಿಡ
8. *Asteracantha longifolia*—ಕೊಳವಂಕೆ, ನೀರುಗೊಬ್ಬಳಿ ನೀರ್ಮುಳ್ಳಿ
9. *Celosia argentia*—ಅಣ್ಣೆಸೊಪ್ಪು
10. *Centella asiatica*—ಒಂದೆಲಗ
11. *Chenopodium album*—ಹುಚ್ಚು ಚಕ್ಕೋತ
12. *Commelina communis*—ಗುಬ್ಬಚ್ಚಿ ಬಾಳೆ, ಕನೆ ಸೊಪ್ಪು
13. *Croton sparsiflorus*—ಅಲ್ಪ ಭೇದಿಸೊಪ್ಪು
14. *Cucumis sativus*—ಬುಡುಮೆ
15. *Cyanotis axillaris*—ನೇಗಲು ಕನ್ನೆಸೊಪ್ಪು, ಗೊಲಗಂಡಿ
16. *Cynodon dactylon*—ಹರಿಯಾಳಿ, ಗರಿಕೆ
17. *Cyperus rotundus, Nut grass*—ತುಂಗೆಹುಲ್ಲು, ಕೊನ್ನಾರಿಗಡ್ಡೆ
18. *Eclipta alba*—ಗರುಗಲು, ಅಜಗರ
19. *Euphorbia geniculata*—ಭೇದಿಸೊಪ್ಪು
20. *Euphorbia hirta*—ಅಚ್ಚೆಗಿಡ
21. *Heliotropium indicum*—ಜೇಳುಮಣಿಗಿಡ
22. *Leucas aspera*—ತುಂಬೆ
23. *Mollugo cerviana*—ಕಾಗೆ ಪುರಳೀಗಿಡ
24. *Ocimum canum*, Hoary Basil—ನಾಯಿತುಳಸಿ
25. *Oxalis corniculata*—ಪುಳಂಪುರಚಿ
26. *Physalis minima*—ಗುಪ್ಪಟ್ಟೀಗಿಡ, ಸಣ್ಣಬುಡ್ಡೀಗಿಡ
27. *Sesbania paludosa*—ಕರೀ ಜೀನಂಗಿ
28. *Sphæranthus indicus*—ಮೂಡಿಗಿಡ, ಮೂಡುಗಟ್ಟಿನಗಿಡ, ಕರಂಡೆ.

# STRIGA ON SORGHUM

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Striga commonly known as witch-weed is a phanerogamic root parasite belonging to the order of *Scrophulariaceæ*. This is known to occur throughout the tropical and subtropicial regions of Africa, Asia and Australia. In India, it is widely distributed and has been reported to occur from Punjab in the north to Travancore in the south. Striga has only about 10-12 hosts among the cultivated crops, but it has 4-5 times this number amongst the wild grasses. In its wild habitat, it has not been found to get better of the hosts, the grasses being more aggressive and vigorous. It is an annual semi-parasite mainly on *Graminæ*. It is a pest on other crops like sugarcane and maize. In India, *jowar* forms the principal cultivated host of striga.

Striga passes a portion of its life-history underground in the form of a tender white shoot. Later, it grows aboveground into a slender stem. It branches freely and bears decussate pairs of linear leaves and spike of white flowers. The adventitious roots which arise from the underground portion of the stem, branch freely and come into contact with the roots of host plants. At such point, haustoria grow out from the striga root and penetrate that of the host plant. Striga derives most of its nutrients through these haustoria and grows at the expense of the host plants. The growth and metabolism of the host plants are considerably retarded because of the depletion of nutrients and water and, in extreme cases, the host succumbs to the parasite and dries up without completing its life-cycle.

Four species of striga are known to attack sorghum. They are: (1) *Striga lutea*; (2) *Striga densiflora*; (3) *Striga euphrasioides*; and (4) *Striga orobanchioides*. They are classified mainly on the number of ribs on the calyx and colour of the corolla. Of these, only the first two are the South Indian species that are commonly found to do considerable damage to sorghum. The important characteristics of these are furnished in Table I.

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TABLE I

| *S. lutea* | *S. densiflora* |
|---|---|
| 1. Germinates better in darkness. | 1. Germinates only in darkness. |
| 2. Does not dry black. | 2. The whole plant dries black. |
| 3. Thinner stem. | 3. Thicker stem with thicker leaves. |
| 4. Flowers white with yellowish tinge. | 4. Flowers white with bluish tinge. |
| 5. Calyx ten-ribbed, occasionally fifteen-ribbed, with secondary ribs ending at series with lobes. | 5. Calyx five-ribbed, ribs running to apex of each lobe. |

It is not uncommon to see hundreds of these parasites sticking on to the roots of the *jowar* plants. The seeds of this parasite are tiny and millions of them are seen in the soil in endemic areas. These germinate in the soil, by the help of a stimulus that *jowar* roots extend to them. The germinated striga attaches itself to the thin fibrous roots of the growing seedlings of *jowar*. For nearly 2 months, it will be growing below ground. During this period, from an examination of the crop, it will not be possible to say whether any attack of striga is present. Striga slowly makes its appearance as small green plants, growing at the foot of the host plant and also between the lines of *jowar*. In the course of a month, these grow to a height of 6" to 1' with green leaves and white flowers. They produce a very large number of small dark-coloured seeds in their capsules and shed them on the ground. The ripening of the striga practically coincides with the host plant. By the time the *jowar* is harvested, the striga has shed its seeds and added infection to the soil. The striga seeds are washed into lower fields in a catchment, by running rain-water which flows from field to field and the infection is thus spread.

Striga is present in almost all the districts of Deccan to a greater or lesser degree. The chronic areas are the Ceded Districts. The damage caused by striga in years when it is very severe has been estimated to be more than 50 per cent. of the yield. In normal years, the estimated loss due to striga attack, in chronic areas, is about 20 per cent. of the yield. It has been reported in as many as 13 districts of Madras State. Nearly two million acres are grown to *jowar* every year in Ceded Districts alone. Taking 20 per cent. as the reduction in yield due to the

attack of striga, the estimated loss of foodgrain (*jowar*) from Ceded Districts alone, works out to four lakhs of short tons (1 short ton = 2,000 lb.) of grain per annum, the standard yield being 400 lb. per acre.

In order to mitigate this loss, a scheme for the control of striga on *Sorghum* in Madras State was started in 1949-50, with a twofold objective. They are, *viz.*, (*i*) to evolve homozygous strains of sorghum resistant to striga, and (*ii*) to find out suitable agronomic methods to control striga. The scheme was sponsored by the Madras Government and was partly financed by the Indian Council of Agricultural Research.

Earlier studies made at Poona on the histology and physiology of striga have thrown considerable light on many aspects of parasitism of striga on *jowar*. Based on these results, further studies were made in the four centres (*viz.*, Guntur, Nandyal, Hagari and Coimbatore) to evolve resistant strains suitable for each zone, as the varieties grown in these centres differed from one another. Experiments conducted at the Agricultural Research Station, Hagari, revealed the following interesting results. Control by agronomic methods like trap-cropping, mechanical methods of uprooting striga by deep ploughing or frequent weedings, spraying with the patent weedicides and soil treatments with chemicals, were tried. Though the results in some of these control methods are fairly effective, they were found costly for application on a field-scale. *Jowar* is commonly grown in drylands and yields only a small margin of profit. Hence deep ploughing, clean cultivation, frequent weedings and the like would be far too expensive. It has therefore been realised that a permanent solution lies only in the evolution of *jowar* varieties resistant to striga.

Seeds of *jowar* reputed for striga resistance from all States in the Indian Union were tried. In addition, a large number of apparently resistant sorghum plants collected during the survey from the striga infested areas were also tested. The breeding trials have revealed that among the comparatively large number of *jowar* types tested, there is to be found no complete immunity to striga attack in any of them. Among the collections, two exotic types (*viz.*, Bonganhilo—A.S. 4003 and Bilichigan—A.S. 4963) proved to be highly resistant to striga. Of the two, the former is superior to the latter in point of resistance. Resistant selections collected locally were also tested in striga-sick plots. As there was no inherent resistance to striga

attack in any of the local varieties, these failed to withstand striga in the succeeding years. Hybridization with exotic varieties was therefore resorted to with the object of transferring the high degree of resistance present in them to the local types. Many of the hybrid progenies exhibited a high degree of resistance. The exotic type—"Bonganhilo"—has undesirable earhead and grain characters. A sufficiently large number of resistant segregates, combining the good grain colour and other economic characters of the local varieties, along with the high degree of resistance to striga have been isolated. These require further purification before release. It may also be mentioned here that certain harmone weedicides like 'Feronoxone', etc., have been found to be effective in killing striga plants in their earlier stages. Experiments to find out the economics of their application on a field-scale are still under way.

# ON THE HABITS AND LIFE-HISTORY OF *MICROBRACON HEBETOR* SAY., A LARVAL ECTOPARASITE OF THE RICE MOTH, *CORCYRA CEPHALONICA* ST.

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*Microbracon hebetor* Say. first attracted serious attention in Mysore in 1937 when it was found to interfere greatly with the breeding of the rice moth (*Corcyra cephalonica* St.) employed as the laboratory host for the mass production of the beneficial egg-parasite *Trichogramma minutum* R., for the biological control of sugarcane-borers in the Visvesvaraya Canal Tract. It was a great nuisance in certain months of the year when the output of host material was considerably reduced by its activity. Female adult parasites were capable of penetrating into the superficial layers of broken *jola* (spread out in wooden trays and infested with rice moth eggs) in search of host larvæ for oviposition, and even muslin cloth used for covering the trays did not prevent parasitisation of larvæ. By keeping light traps regularly and by maintaining a sufficient depth of grain in the rearing trays, the incidence of this parasite pest was brought to manageable proportions.

Subsequently, the possibility of harnessing this parasite to a beneficial purpose has been extensively explored in this laboratory and elsewhere. Known to have a wide range of Lepidopterous hosts, it has been successfully bred in this laboratory on the larvæ of *Adisura atkinsoni* Moore by Krishnamurti and Appanna,[5] *jola* earhead caterpillar, *Stenachroia elongella* Hamp. by Appanna,[1] ragi stem-borer, *Sesamia inferens* Wlk. by Syed Usman and Krishnamurti,[10] potato tuber moth, *Phthorimœa operculella* Zell. and sugarcane stem-borer, *Argyria sticticraspis* H. by Appanna.[2] Negi, Venkataraman and Chatterjee[8] have bred it on larvæ of *Holcocera pulverea* Meyr., *Eublemma amabilis* Moore, *Ephestia cautella* Wlk., *Platyedra gossypiella* Saund, and *Corcyra cephalonica* St. Appanna[2] has worked out a method for the mass production and utilisation of this parasite against field pests. Thus the destructive proclivities of this Braconid parasite have been sought to be put to useful purposes with a conspicuous measure of success.

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In this paper observations made by the author on the copulation and egg-laying habits of *Microbracon hebetor* and the ovipositional record of an exceptionally fertile female are briefly described.

### 1. Copulation and Oviposition

Copulation occurs readily in captivity ; the male descends suddenly on the female, which, if not prepared for mating, shakes off the former by rapid up-and-down movements of its wings or by violently shaking its entire body and brushing its wings with the hind legs. Usually, it is when the female parasite is intent on stinging a host larva as will be described later, that it wards off all attempts at mating by the male. When successful, the male mounts over the female and copulates by bending its abdomen downwards and forwards.

Only the late-instar host larvæ are preferred for egg-laying ; while engaged on stinging a larva the female parasite makes a few quick passes round it and suddenly plunges its ovipositor deep inside, withdrawing it hastily if the larva wriggles about. It then remains motionless for a while nearby with the ovipositor fully extruded and directed forwards and the abdomen nearby doubled on itself. When the larva is quiet it is pierced again, and so on till it is rendered 'inert' and suitable for egg-laying. In the intervals of stinging, the mouth is occasionally applied to the punctures probably to suck up the extruding body-fluid. Since stings are administered anywhere on the host body, it is probable that some poison is injected inside rather than that some nerve centre is affected to bring about general paralysis.[6] The parasitised larvæ generally lie in a slightly twisted or distorted position with old puncture marks clearly visible due to their edges becoming discoloured. There is at first a slow and spasmodic pulsation of the dorsal vessel which becomes more feeble, finally stopping altogether.

Usually oviposition does not occur on all the stung larvæ. No particular part of the host-body is favoured for egg-laying, though the highly chitinised head region is avoided. They are laid in small clumps of up to about 6 eggs in each. The number of eggs laid by a female parasite on one day and on 4 late-instar larvæ was 35, distributed as follows :

Larva No. 1. 6 eggs on 2nd abdominal segment (dorsal).
6 on 6th abdominal segment (dorsal).
Larva No. 2. 4 on 2nd abdominal segment (ventral).

5 on 5th abdominal segment (ventral).

Larva No. 3. 1 on 5th abdominal segment (ventral).

Larva No. 4. 2 between 2nd and 3rd thoracic segments (ventral).

3 on 1st abdominal segment (lateral).

5 between 5th and 6th abdominal segment (lateral).

3 on glass surface near 3rd abdominal segment (ventral).

The period of oviposition and the egg-laying capacity appear to vary greatly; in the two instances recorded it was 5 days and 184 eggs (16 host larvæ), and 22 days and 594 eggs (42 host larvæ) respectively. This high egg-content and wide range of variation is difficult to explain. Besides, Glover and Chatterjee have recorded a maximum number of 48 eggs only per female. In both instances recorded above the male parasite died a day or two after setting up the experiment and each day a set of new host larvæ (3 or 4) were introduced. In the following table is given the ovipositional record of the female parasite which laid 594 eggs in a period of 22 days.

Ovipositional Record of a Female Parasite

1st day: introduced 1 female and 1 male (both emerged the previous day) into petri dish with 3 Corcyra larvæ.

2nd day: 26 eggs; 2 larvæ given.
3rd day: 26 eggs; 2 larvæ given; male dead and removed.
4th day: 46 eggs; 2 larvæ given.
5th day: 37 eggs; 2 larvæ given.
6th day: 48 eggs; 2 larvæ given.
7th day: 39 eggs; 2 larvæ given.
8th day: 33 eggs; 2 larvæ given.
9th day: 45 eggs; 2 larvæ (small) given.
10th day: 6 eggs; 3 larvæ (small) given.
11th day: 31 eggs; 2 larvæ (small) given.
12th day: 19 eggs; 2 larvæ given.
13th day: 22 eggs; 2 larvæ given.
14th day: 16 eggs; 2 larvæ given.
15th day: 22 eggs; 2 larvæ given.

16th day : 30 eggs ; 2 larvæ given.
17th day : 32 eggs ; 2 larvæ given.
18th day : 16 eggs ; 2 larvæ given.
19th day : 35 eggs ; 4 larvæ given.
20th day : 6 eggs ;
21st day : 20 eggs ; } No larvæ given.
22nd day : 24 eggs ;

23rd day : 15 eggs ; No larvæ given. Parasite inactive, incapable of movement, but abdomen not shrunk. 2 larvæ given ; 1 male parasite introduced.

24th day : female parasite dead with abdomen shrunk ; larvæ not stung.

The inert covering separating the parasite from the host considered necessary by Salt[9] and other workers for successful parasitisation by ectophagous parasites, specially *Microbracon*, does not appear to be such a prime necessity in this case, since in these observations *M. hebetor* was seen to attack exposed hosts directly. Of course, it could successfully get at larvæ hidden under webbing or behind cloth or other types of inert material. But it was equally at home with exposed larvæ, which had no protection except sometimes a few strands of silk spun just then. It is probable that *M. hebetor* is able to do without the inert cover when tackling exposed larvæ, since it requires no protection from the wriggling movements of such exposed larvæ when stung as it can easily fly away from their range.

## Life-History

These observations are based on studies on the development of two lots of 10 and 12 eggs, respectively made during late summer (average temperature maximum 83·5° F., humidity 63°).

Eggs are ovoid, clear and transparent measuring about 0·5 mm. long. Those laid on the glass surface which did not find anchorage on the larval body failed to hatch out. Egg-stage 1 to 2 days. Freshly hatched grubs about 0·3 mm. long, pale clear, anterior end slightly glistening, posterior end tapering and slightly curved. They appear to have a loose hold on the host-body since a large proportion of them drop down and die. On the second day, the grub is pale-yellow in colour, thick-set, 3 mm. long and 1 mm. broad in the middle, posterior end rounded and curved towards the ventral surface. They are

seen to be wriggling actively on the host-body for accommodation and feeding facilities. On the third day, grubs measure 5 mm. long and 2 mm. broad and are pale yellow in colour with rows of white spots (fat-bodies) inside the body; they wriggle about actively and tend to move away from the host-body for pupation. Some begin to construct cocoons even on the third day; on the fourth day pupation is completed, cocoons being found all round the host which is completely shrivelled up and discoloured by then. Cocoon 3 mm. long, 1 mm. broad, tough in texture, spun of white silken strands, thick, translucent and arched above and thin, transparent and flat below; anterior end rounded, posterior end with a slight nipple-like projection; a small dark mass of larval meconium is thrust far into posterior end; intertwining white strands connect the cocoons together and serve to anchor them firmly to the glass surface; pupæ appear slightly shrunken with darker eyes visible to the naked eye. On the sixth day, eyes darker still, thorax deep brown, darker than abdomen. On the seventh day, antennæ, wing-pads, ovipositor (in female) and dorsal region of abdomen and thorax darker than rest of body which is brownish-yellow in colour. On the eighth day, wing differentiation is completed. Emergence may occur later on the same day or on the ninth day.

An irregular exit hole is cut at the anterior end of the cocoon by the emerging parasite.

Thus the entire period of development is about 8 to 11 days (average 9·7 days) as follows:

| Stage | No. observed | Min. | No. | Max. | No. | Average |
|---|---|---|---|---|---|---|
| Egg . | 22 | 1 days | 7 eggs | 2 days | 15 eggs | 1·7 days |
| Larva .. | 19 | 3 days | 8 larvæ | 4 days | 11 larvæ | 3·6 days |
| Pupa .. | 15 | 4 days | 9 pupæ | 5 days | 6 pupæ | 4·4 days |

This approximates to the minimum developmental period (10 days) mentioned by Glover and Chatterjee[4] (the maximum of 18 days was taken only in the fifth generation in their work) but is shorter than the period of 20 days mentioned by Myers[7] in Australia. The larval period 'within the cocoon' mentioned by Glover and Chatterjee, also referred to by Myers as the interval between spinning and pupation (probably corresponding to the 'pre-pupa' of Glover[3]) is not so conspicuous

here and is probably restricted to the interval of one day required for spinning the cocoon. Pupation occurred with apparent ease in glass petri dishes, though no other kind of support was provided to facilitate it as is stated to be necessary by Glover and Chatterjee.

Unfertilised females readily lay eggs, the progeny from such parthenogenetic eggs being all males. One unmated female produced a total offspring of 135 male parasites on 21 host larvæ.

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# FRUIT TREES IN THE KITCHEN GARDEN

## II. Papaya

By Dr. T. M. Paul*

Papaya (also called Papita) is one of the heavy-yielding and early maturing fruit trees. Its cultivation is also easy in the sense that once the tree is planted it needs very little attention for a number of years. This is the reason why it is a common fruit tree in kitchen gardens. But still, many people do not realise how easy it is to grow a few papaya trees in the kitchen garden. The author planted just three papaya seedlings in his small kitchen garden in 1949 of which one was spoiled by monkeys and only two grew up. The seedlings were purchased from the local Government garden thinking that they were the best. The photograph shows the trees with fruits.

Although they did not come upto the expectations, since the beginning of 1950, the author had a regular supply of papayas till the end of 1953, when one tree was cut down due to stem-rot. Even now, the one remaining tree is giving a good supply of medium-sized papayas. In the author's opinion every kitchen garden should have a few papaya trees. Hence this article, narrating the author's experience with papaya cultivation on a small scale.

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*Habitat.*—Papaya is a beautiful shrub rather than a tree. Usually it grows into a single straight stem with symmetrical, palm-like leaves at the top. This makes it a beautiful avenue-tree on the sides of roads leading from the gate to the house. It requires moderately rich and well-drained soil. The tree cannot stand water-logging. Since the stem of the tree is hollow, it is not very strong and is likely to give way when heavy wind blows. Even the roots do not go deep; this is why papaya tree very often falls off in heavy wind. Usually the tree does not grow more than 20′ high. Still, due to its weak-stemmed nature, it is better to have dwarf varieties in a plantation or some sort of a wind-break crop has to be grown around. In the kitchen garden it may be planted in suitable places to get maximum protection from the wind.

*Varieties and Types.*—There are not any very definite varieties in papayas although people designate certain varieties like Ranchi, Washington and Ceylon. Rather than buying seeds or seedlings from anywhere, it will be advisable to get a fruit from a heavy-yielding tree from the same locality where you intend planting it. Only when the tree flowers, one will know whether it is a male or female plant. The male trees do not bear fruits and hence should be removed as soon as noticed.

*Propagation.*—Although papaya trees can be propagated by cuttings,[1] raising seedlings from fresh seeds seems to be the best method of propagation. The seeds may be collected from sweet fruits from healthy trees. The longer and bigger the fruit, the better. The seeds may be dried in the sun and then germinated on a seed-bed. The seed as well as the seedlings have to be protected against birds and fowls. If the seeds are sown about 8″ apart, they can remain on the seed-bed itself till they are transplanted; otherwise they have to be transplanted to another seed-bed when the third leaf appears. The seed-bed should be a little raised for proper drainage of water. The plants will be ready for transplantation in a couple of months if the seed-bed is well manured with farmyard manure. So, if the seeds are put in March-April, the trees can be transplanted when the monsoon sets in in June.

*Transplantation.*—Two to three feet square pits may be dug to a depth of 2-3′ at a distance of 8-10′ in between, in any

[1] Cuttings of ripe shoots with the leaves in tact will, it is reported, root readily in sandy soil. Good varieties may also be propagated by grafting young seedlings. Such grafted plants come to bearing early.—*Ed.*

vacant corners of the kitchen garden. These may be got ready a couple of months before the monsoon sets in, so that they can be filled gradually with kitchen waste, farmyard manure, poultry-run sweepings, etc. The seedlings may be removed from the seed-bed with a ball of soil surrounding the roots and planted about 1′ deep in the middle of the pit and watered.

*Looking After the Plant.*—Except in the rainy season, the plant needs watering once a week or at the most, twice a week. It is possible that watering may be too much in a kitchen garden, particularly when the tree is near the wash-up place. This is to be avoided, particularly in the case of papaya trees, as it causes stemrot. Farmyard manure or any artificial manure may be applied at least twice in an year, preferably at the beginning and about the end of the monsoon season. It is also necessary to hoe round the plants as the soil is likely to get set in a kitchen garden due to frequent watering and people walking about. This helps also in removing the weeds, aerating the soil and conserving the moisture.

*Fruits.*—The papaya tree starts yielding fruits in less than an year, depending upon the variety. The average life of a tree is about 10 years and the yield is at its best in the first 3 years. The average yield of a tree is about three to four dozen fruits weighing about 4-6 lb. each. There are some trees which branch out and, if the branches are allowed to grow, give a much greater yield. In this respect, papaya tree is one of the high-yielding fruit trees. It is advisable to thin the fruits as they set, in order to get big and uniform-sized fruits. The fruits may be plucked when they start ripening.

*Nutritive Value.*—Among fruits, papaya is one of the few fruits very rich in carotene and vitamin C and moderately rich in carbohydrates and hence in calorific value. Apart from these, it has a pleasant and agreeable flavour. Besides all these, it is perhaps the cheapest of fruits which accounts for its great popularity. Even the green papaya can be used in a variety of ways in the kitchen for various preparations.

Considering the ease of cultivation, beauty of the tree, the high yield of fruits and the nutritive value of the fruit, papaya deserves a place in every kitchen garden. And in these days of high cost of living when middle class families cannot afford to buy any fruits, a few papaya trees in the kitchen garden can solve the problem of fruits in the family-diet to a great extent and satisfactorily too.

# DAMAGE TO POTATO BY EEL-WORMS*

By S. Usman[1]

Eel-worms are very minute worms which attack cultivated crops of different kinds and often cause serious damage. They have been noted on numerous crops all over the world, and in South India the most important ones subject to such attacks are coffee, tea, cabbage, mustard, brinjal, tomato, etc. Now a species (*Heterodera* sp., Nematyhelminthes) has been noticed on potato in Chikmagalur. The damage caused by them consists in the worms attacking the rootlets of the plants and causing the characteristic knots or nodules in which the worms breed. The heavily infested plants become yellow, wilt during hot days, and are eventually stunted in growth. Root crops, such as potatoes, are rendered unsaleable by the tumerous swellings. (Fig. 1).

The eel-worms exist in the soil as active young larvæ (Fig. 2) or unhatched larvæ. The latter are liberated from the host plants by decay of the infested root tissues. When soil temperature and moisture conditions are favourable, the encysted worms disrupt the envelopes and become active. They squirm and wriggle about. Coming into contact with the root of the host plant, they enter the tissues, and thus establishing a connection with an abundant food supply, grow rapidly. The adult female worm is about the size of a pin-point, and the body is distended into a sac by the growth of many embryos therein. The embryos are extruded by the female into the plant tissues and are eventually left in the soil. The plant tissues respond to the attack of the worms and the characteristic swellings are thus produced. Often the injuries caused by the eel-worms serve as places of entrance for various other organisms such as fungi and bacteria which bring about a rotting of the root tissues.

*Control.*—It becomes a difficult problem to control the eel-worm pest when the field is badly infested, since a sufficient number of eel-worms are always left in infested soils to injure the next susceptible crop. A thorough sterilisation of the soil will be an effective remedy : sterilisation may be (*a*) by steam,

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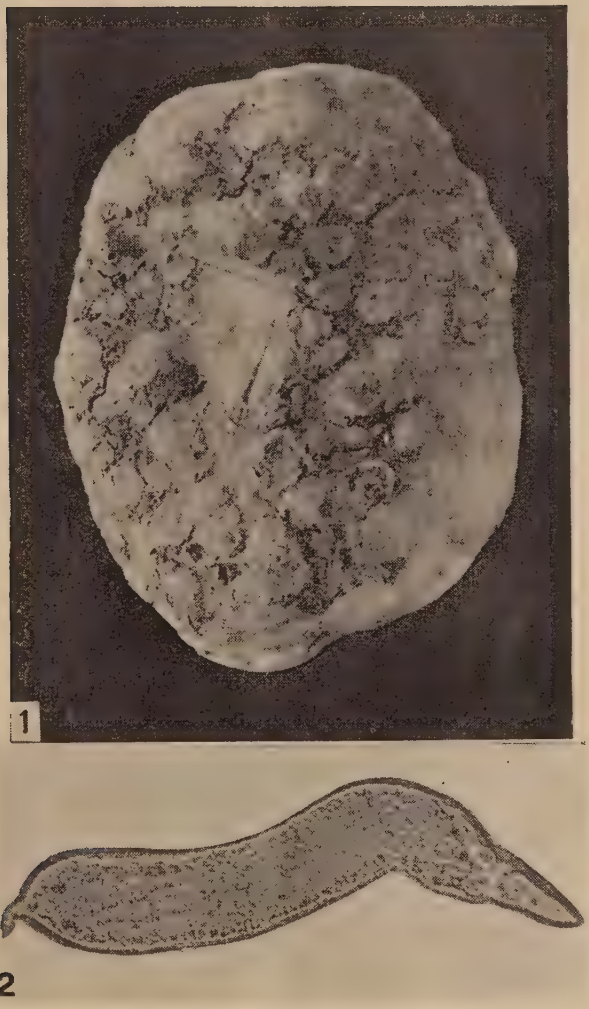
* This note was prepared in 1947, but could not be published.

[1] Division of Entomology, Dept. of Agriculture.




1. DAMAGED BY EEL-WORM
2. EEL-WORM

or (*b*) by chemicals, such as carbon bisulphide. Since this treatment is not practicable in the field under the existing conditions in Mysore, the following measures should be adopted :—

(1) Digging out the soil to about $2\frac{1}{2}'$ and exposing it to intense sun for about 2 weeks;
(2) Keeping the land fallow for a few seasons;
(3) Rotation of crops; and
(4) Complete destruction of the infested tubers along with the plants bearing them. Such tubers should never be used for seed purposes under any circumstances.

# JAGGERY, BOORA SUGAR AND OPEN PAN SUGAR

By K. Lakshminarayana Bhatta*

## I

## GENERAL CONSIDERATIONS

The manufacture of jaggery is an important industry in the State. It is a cottage industry in the true sense of the term. It is carried out in the villages. It engages and gives employment to village artisans such as the carpenter, the smith and the mason. It offers employment to agricultural labourers during the summer months when they are otherwise forced to be idle. It is one of the few industries, perhaps the only one in which the whole process from the growing of the raw material to the manufacture, and sometimes the sale, of the final finished product is done by the same individual, the village cane-grower. The process itself is simple, and relatively inexpensive and the finished product has a ready market, as jaggery is a common article of food both among the rich and the poor. As an industry engaging the idle time of the agriculturist and providing an essential article of every day requirement, jaggery production deserves to be organised and put on a planned basis. The conditions for such development are quite favourable as can be seen from a study of the raw material position and other related factors.

### The Raw Material

Sugarcane and the date palm are the two plants from which jaggery can be prepared. The latter is as yet an untapped source, with great potentialities for the future. Palm jaggery manufacture is being sponsored on an all-India basis and Mysore has a pilot scheme for its production on an experimental scale. Its future development depends largely on the experience gained there, and it may take some years before it becomes quite well established.

The other plant, sugarcane, is cultivated extensively and its production can be considerably increased both by an extension of the area under the crop and by upgrading the yield per acre.

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## Area under Sugarcane

The following table gives the average acreage under sugarcane in Mysore from 1905 to 1950.

| | | |
|---|---|---|
| 1905-1906 to 1914-1915 | .. | 39,420 acres. |
| 1915-1916 to 1924-1925 | .. | 35,385 acres. |
| 1925-1926 to 1934-1935 | .. | 37,073 acres. |
| 1935-1936 to 1944-1945 | .. | 47,446 acres. |
| 1945-1946 to 1949-1950 | .. | 48,170 acres. |

The sharp rise in acreage from 1935 onwards is due to the development of the Visvesvaraya Canal Tract and the establishment in Mandya of a sugar factory. The current acreage, including the Bellary District is about 60,000 acres. The completion of the Bhadra Project (Lakkavalli) will bring an additional 3,00,000 acres under irrigation of which 1,20,000 acres will be suitable for sugarcane cultivation. When the lands under the Thungabhadra Project (Hospet) are fully developed, an additional area of 15,000 acres in Bellary District, will come under sugarcane. It may therefore be expected that in the near future, the area under sugarcane in Mysore may well be more than 1,00,000 acres. Allowing for the establishment of new sugar factories and the expansion of existing ones, it may be assumed that the crop from at least 50,000 acres will be available every year for the manufacture of jaggery.

## Yield per Acre

The Agricultural Department has several improved sugarcane varieties[1] which can be adopted into cultivation in different parts of the State. The manurial requirements and cultural practices required for the production of high yields of cane, have also been determined. By combining high-yielding varieties with liberal manuring, the yield per acre can be considerably increased. In the two factory zones at Mandya and Hospet, the average yields are 25 and 30 tons respectively. The normal yields in some of the principal jaggery areas of the State, as furnished by experienced cane-growers of the locality, during a recent survey are :

Bangalore—30-35 tons; Kunigal—30-35 tons; Shikaripur—30-35 tons; Gubbi—35-40 tons; Belur—35-40 tons; Malur—40-45 tons.

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[1] A list is furnished at the end of the note.

Recently, the Mandya Sugar Factory raised a 100 ton crop in one of their farms and the average yield of cane in the factory farms is over 40 tons per acre. In a crop competition held this year at Hospet, the highest yield obtained was 70·25 tons. Individual cultivators in well established jaggery areas have achieved in their fields, yields of over 50 tons per acre.

Therefore, considering both the area available for sugarcane cultivation and the yield factor, the raw material position for the jaggery industry may be taken as satisfactory.

### Mechanical Equipment Required in Manufacture

These are: (1) The sugarcane crusher, (2) The furnace and pans, and (3) The cooling pan, moulds and other accessories.

*Crushers.*—The total replacement of wooden, by iron mills has greatly improved the efficiency of extraction and increased the outturn of jaggery per ton of cane. Established firms like the M/s. Kirlosker Co., and the P. S. G. Industrial Institute and M/s. Madurai Mudaliar & Co., have placed on the market, three-roller iron mills which give an extraction of about 60 per cent. and which can be easily assembled, worked and cleaned. Different types suitable for use with animal traction or with power attachment according to individual requirements are also available. While some further improvement in the design of the mills so as to enhance their efficiency is desirable, their present performance is fairly satisfactory.

*Furnaces.*[2]—The Hebbal double-pan furnace and the three-pan furnace designed for use in the preparation of cream jaggery are quite suitable for general adoption. The Hebbal furnace has proved its worth over the past twenty years and more, and has been in use in many parts of the State. It is easy to construct and maintain, economical in use and runs entirely on begasse. Its adoption in all parts of the State where it is not already in use will go a long way to make our jaggery cleaner and cheaper.

*Moulds.*—Jaggery is prepared for the market in various forms, *viz.*, slabs, balls, hollow cubes and pyramids. Of these, the last two are to be preferred as they require least handling in process, and can be prepared by running the hot syrup into moulds and taking them out of the moulds after cooling. The Agricultural Department has designed a standard wooden mould

which can be taken apart, cleaned and re-assembled easily. It is made in two sizes, to give pyramids weighing 2 oz. and 1 lb.[3] respectively. These moulds are large enough to receive the entire syrup from one charge, *viz.*, about 2½ local maunds. Their adoption on as wide a scale as possible has to be encouraged. Their use makes for uniformity of size and shape of jaggery blocks and gives a distinctiveness to Mysore jaggery that will offer certain advantages to the trade. Jaggery prepared on these moulds will be easier to pack, transport and store and it will also render grading and valuation for the trade less complex.

*Other Accessories.*—These include the cooling pan, the skimming ladles, scrapers, sieves, etc., which can be procured locally.

### Skilled Workers

These fall into two groups: (1) the carpenter and smith and the brick layer who have to instal, run and repair the mill and furnaces; (2) the jaggery maker who converts the milled juice to jaggery. The first type of worker is usually available in the village and as the 'machines' to be used are relatively simple, their erection and care is well within the skill and competence of village talent.

Judged by numbers, there is no dearth for the second category of workers, namely, the jaggery makers. These are either members of the farmer's family or professional jaggery boilers who make a living by hiring their skill during the season. This latter class usually form part of a moving jaggery outfit, who ply their trade wherever it is needed. But the method of preparation followed by them is often crude and results in a poor type of jaggery. The Department offers facilities on its farms for training in jaggery-making and wider use of these facilities by jaggery-makers will improve both the efficiency of manufacture and quality of the product.

### Markets

Mysore has so far been self-sufficient in point of jaggery and has a limited export trade in the commodity, averaging about 6,000 tons a year. There is evidence to show that the *per capita* consumption of jaggery in Mysore is on the increase. The estimated production of jaggery in Mysore in 1933 was 35,000

[3] These are known as Babbar and Hebbal moulds respectively.—*Ed.*

tons and in 1952, over 75,000 tons. While the production was thus doubled, the export remained more or less steady at 6,000 tons. Making due allowance for the increase of population during the period, the actual *per capita* consumption is obviously on the increase.

The question naturally arises, whether there will be an assured market, when a programme of larger production is achieved. The *per capita* consumption of jaggery, taking India as a whole, has varied from 20-26 lb. during the past two decades and with an improvement of living standards, this rate may be expected to be exceeded. This, coupled with an increase of population, will no doubt provide a ready market for all the jaggery that may be produced. In fact, the Indian Central Sugarcane Committee has been suggesting that in view of the increased population, there would be an increased demand for jaggery and that it would be necessary to take up developmental activities to augment production. Nor need there be any fear that increasing production of sugar would have an adverse effect on the jaggery market as sugar is no substitute for jaggery, except in a very limited sense. Also the phenomenal increase in the number of sugar factories during the past two decades has had no adverse effect on the production and consumption of jaggery.

## II

## QUALITY JAGGERY[4]

What is 'quality' in jaggery ? It is mainly a combination of colour and taste and complete freedom from dirt. A golden yellow colour, hard grain, and a sweet taste devoid of any saltish or acid flavour, represents the best standard of quality. This can be achieved by attention to a few details and the exercise of care and judgment in the choice of material and in its handling. The main thing is to know what to do and what to avoid and use our knowledge to advantage.

### The Raw Material

The starting point for good quality jaggery is good ripe sugarcane. Both immature cane and overaged or lodged cane contain less cane sugar and more invert sugar than properly ripe cane. Juice from such cane does not set properly and if

[4] Portions of this article appeared in the *Mysore Agricultural Calendar and Year-Book* for 1954.—*Ed.*

more lime is added, as is often done to induce setting, the jaggery becomes dark and saltish.

The maturity of a cane crop can be judged by means of a hand refractometer. In ripe cane sugar is distributed evenly in all parts of the stalk, from top to bottom. In an immature cane, the top portions contain less sugar than the bottom portions. If the 'Brix' reading of the top joint and bottom joint of a cane is taken, the two values will be nearly the same if the cane is ripe, 'Brix' representing the total solids in the cane juice, of which sugar is the chief constituent. Ripe cane gives a Brix reading varying from 18 to 22 per cent. By taking the Brix reading of 20-30 canes chosen at random in an acre field, by means of the hand refractometer, the state of maturity of the crop can be judged. Farmers who grow sugarcane regularly year after year would do well to possess this instrument. It is handy, reliable, easy to use and lasts a life-time or longer. It costs about Rs. 250.

Those who cannot afford a refractometer have to depend upon their personal experience and a knowledge of the age of the crop. With the varieties now in cultivation in the State, sugarcane planted from December to April ripens in 12 months, that planted from July to November in 14-15 months and that planted in April or May can be harvested only the following October, when the crop is 18-months-old.

Arrowing is no proof of maturity. The arrow is the flower of sugarcane. Like other flowering plants which flower in particular seasons, flowering varieties of sugarcane arrow during October and November every year. While it is true that a cane stalk which has arrowed ceases to grow, there is the possibility that it accumulates sugar and becomes sweeter. Also, all the canes in a stool do not arrow (except in a few varieties) and those that don't arrow, continue to grow. The age of the crop and not its arrowing should, therefore, be the guiding factor in judging maturity.

Ratoons mature about a month earlier than plant cane.

### Harvest

At harvest, the cane must be cut close to the ground as the bottom portions are the richest in sugar and contribute most to the outturn of jaggery. It should be topped just above the last coloured joint, or if the tops are to be used for setts, two

joints lower. It must be freed from all trash, and as far as possible, the buds must be scraped off as they contain no sugar, but much tannin, which makes the jaggery dark. The cut cane should be stored in shade and milled without undue delay. Storage for more than 24 hr. during summer causes serious drying and inversion, lowers the quality of the juice and consequently of the jaggery.

### Milling

Keeping the mill clean is of great importance. It should be cleaned with plenty of water at the end of each milling. Otherwise, the juice held in the mill parts will get sour and spoil the next charge of juice. The juice coming out of the mill should be filtered through a rough cloth or bamboo strainer to keep out pieces of bagasse and other coarse dirt.

### Clarification

The filtered juice contains, besides sugar, many other substances, such as the colouring matter of the cane, gums, resins, proteins and minerals present in the cane. Some of these are in solution and the rest in a very fine state of suspension or colloidal solution. The art of making good jaggery consists mainly in removing these suspended non-sugars, and boiling the resultant juice without allowing the sugar to invert or break down to invert sugar during the process.

It is worthwhile pointing out to readers that invert sugar is not an 'impurity'. It is a wholesome article of food, sweeter than sugar, and highly palatable. It is formed when a solution of sugar is treated with an acid or boiled for a long time. Its presence or formation in large amounts, during jaggery boiling, makes the jaggery soft, poor-grained and of inferior keeping quality. Hence the objection to its presence in juice, or its formation during boiling, which should be avoided.

The removal of suspended non-sugars is brought about by heat or by the action of chemicals or by both. Their removal in this manner is referred to as clarification and the chemicals used as clarifying agents.

### Some Clarifying Agents

Lime is the most common clarifying agent used in Mysore. Addition of lime to the juice causes the impurities to be thrown out or 'coagulated' and on heating it, these float to the top as

"scum" or "mud". A thorough removal of the scum leaves the juice clear, bright and transparent.

While most jaggery-makers in Mysore are now accustomed to the use of lime, the method followed in many cases is not satisfactory. They use lime powder, which often contains a lot of grit and stone. Also, in their anxiety to get hard jaggery, they add too much of this powder so that a dark saltish product is obtained.

The best way to use lime is as 'lime cream'. This should be prepared every day or alternate days and stored in an air-tight container. For this purpose, freshly burnt quick lime is slaked, stirred well and filtered through a coarse sieve. Metal sieves used for *soji* are satisfactory. Four to five seers of water added to 3 lb. of lime gives a good cream.

Lime cream should be added to the cold juice, avoiding an excess. This can be done in one of two ways. To a pan normally boiling 9 tins of juice, 8 tins are filled, and lime cream added until the juice turns a piece of red litmus blue, or if litmus is not available, till the colour of the juice turns a faint permanent yellow. The last tin of juice is then added. Alternatively, fill the pan and add lime cream a little in excess, and then add a solution of superphosphate till the yellow colour just disappears, or a red litmus paper just fails to turn blue. The superphosphate solution can be prepared by shaking a double handful of superphosphate in 4 seers of water, and allowing to stand for sometime, the clear liquid on top being then decanted and used.

The lime cream added for the first charge on a day is noted and is used for all subsequent charges that day with cane from the same field.

### Mucilaginous Extracts

Mucilaginous extracts from certain plants are used extensively in upper India as clarifying agents. They are added to the hot juice after the first scums are removed. Their addition causes further scums to form and rise to the surface and their removal leaves the juice clear.

One such plant commonly available in Mysore is *Bende* or Ladiesfinger[5] cultivated as a vegetable. The stems of grown up

[5] Okra—*Hibiscus esculentus.—Ed.*

plants are beaten down to pulp and squeezed in water between the fingers. A mucilaginous extract is obtained. This is filtered through a fine cloth and used in the following manner. The raw unlimed juice is boiled and the scum that floats up is removed. Then, about 1 seer of the extract prepared is added and the boiling continued. Fresh scums arise and are carefully removed. The extract is added one or more times till no more scums are formed, and the juice boils clear, with a white foam. The juice is then concentrated as usual and struck into jaggery.

With fresh ripe cane, this gives a good quality jaggery. It is not quite so hard or granular as jaggery prepared with lime clarification, but both the colour and the flavour are pleasing.

### Activated Carbon

The use of activated carbon for clarification of juice in jaggery-making is coming into vogue. Activated carbon is chemically prepared charcoal which has the property of absorbing and retaining, colouring matter, colloids and minerals contained in the juice. Jaggery of a very attractive golden colour, called cream jaggery, can be obtained by the use of this clarificant. The method of preparing cream jaggery has been extensively demonstrated at exhibitions, fairs, Government farms and on cane-growers' fields. The product finds a ready sale and fetches a higher margin of profit than ordinary jaggery. The commercial possibilities of this type of jaggery are great and well worth exploitation.

The process requires some small additions to the ordinary outfit of a jaggery house. They are, two or three sand filters and a wiremesh skimming ladle both of which can be made locally. Their description is given at the end of this note. The process of clarification with activated carbon is briefly as follows :

Juice is taken in the top pan of a double pan furnace and limed as usual and the first scums are removed. Then activated carbon in amounts equal to $\frac{1}{2}$-$\frac{3}{4}$ lb. per 100 lb. of juice is added and the juice stirred briskly for a couple of minutes. Heating is stopped and a little cold water sprinkled on to the juice and it is allowed to stand. In about 10 minutes, the major part of carbon will have settled down to the bottom of the pan, leaving a clear liquid on top. This is drawn to the strike pan, through a sand filter over which a piece of cloth is spread. The sand filter retains practically all the carbon particles, and the

filtered juice in the pan is now nearly colourless, but contains some particles of carbon floating in it. The juice is then heated and scums, as they arise, are removed with the ladle fitted with wiremesh. About $\frac{1}{4}$ seer of dilute milk (1 part of milk to 4·5 parts of water) is splashed on to the boiling juice once or twice. This helps to collect the carbon particles together and facilitates their quick and complete removal. The further boiling and concentration of the juice is the same as with ordinary jaggery.

The success of the process depends, to a large extent, on thorough cleanliness. The sand filters have to be washed at the end of each day's work and the contents renewed periodically.

A three-pan furnace has been designed to facilitate continuous working of the process in which the topmost pan is used for carbon clarification and the other two pans for concentration and striking. With this furnace, five to six charges of clean jaggery can be prepared in the course of a 10-hours day.

### Hydros (Sodium Hydro Sulphite)

Another chemical that is coming into use in the preparation of jaggery is hydros. It is not a clarificant in the strict sense of the word, as it is not added to the juice and does not clarify it. It is added to the hot syrup just before striking or in the cooling pan immediately after striking. It is mainly a bleaching agent, which bleaches the colour of the syrup giving a light-coloured jaggery. For good results, the syrup must be stirred briskly after addition of hydros so that all parts are equally well bleached. The use of hydros is to be deprecated, as it is likely to be harmful to health if used in large amounts and as the improvement in colour is quite temporary. One tola per charge of 9 tins is perhaps the safe limit.

Besides these substances, several others are used as clarifying agents in different parts of India. These include the mucilaginous extracts of plants like *deola* (*Hibiscus ficulneus*),[6] *Semal* tree bark (*Bombax malabaricum*),[7] *Phalsa* (*Grewia asiatica*),[8] and *Sukhali* (*Kydia calicina*[9]); chemicals like sodium carbonate and bicarbonate, alum superphosphate and *sajji*[10] (a crude form of sodium carbonate with sodium sulphate and chloride) and extracts of oilseeds like castor and groundnut.

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6. ಸಣ್ಣ ಕಾಡುಬೆಂಡೆ. 7. ಬೂರಗ. 8. ತಡಸಲಿ ಅಥವಾ ಜಾಣ. 9. ನಾಯಿ ಬೆಂಡೆ ಅಥವಾ ಕೋಳಿ ಬೆಂಡೆ 10. ಚೌಳುಪ್ಪು.—Ed.

### Boiling

Correct boiling is as important as thorough clarification. The success of boiling depends to a large extent on the type of furnace used. The Hebbal double pan furnace is designed to subserve this purpose very well. It is easy to construct and maintain, economical and works on bagasse. The top pan can be used for clarification and the bottom pan for striking, making the process continuous.

The scum must be removed very thoroughly. Jaggery-makers usually put the scum on to a cloth spread over a basket and allow the juice to strain through it into the pan. This is a good practice, provided the cloth is cleaned regularly once or twice during the day. The loss in recovery of jaggery due to removal of the scum is negligible and is more than compensated by the improvement in the quality of jaggery and the higher price it fetches. The scum makes good manure.

The side of the strike pan must be rubbed down periodically with the *gorumane* (ಗೋರುಮಣೆ) dipped in the hot juice to wash down any syrup adhering there. This prevents concentration and charring of the syrup on the sides of the pan.

The firing of the pan towards the end of boiling must be steady and even. After the final froth subsides, and the syrup begins to boil with numerous small bubbles, the striking point is near at hand. The syrup at this stage must be kept continually stirred to prevent local heating and charring.

The striking point must be judged properly. This is a matter of expert experience. Well trained jaggery-makers generally strike the syrup properly. The usual method of judging is to dip the palm of the hand in cold water and collect a little syrup between thumb and forefinger. On rolling this syrup and striking the ball formed on to the pan, a sharp metallic sound indicates the strike point. A more accurate method is to use a thermometer and strike the syrup when it is 117-18° C. But ordinary thermometers are liable to break unless handled carefully and are rather costly. Special instruments called 'Rabometers' which indicate the strike point accurately have been designed by the Institute of Sugar Technology, Kanpur, but these have yet to be introduced in Mysore.

### Finishing

The cooled syrup is either run into moulds to set or rolled into balls of various sizes. Of these two methods, running into moulds is the better practice. It requires less handling and is consequently cleaner. Since the pieces are all of one size and

weight, it facilitates packing and transport. The wooden mould designed by the Department offers several advantages over those commonly used by jaggery-makers. It is made of sections which can be taken out, cleaned and re-assembled with ease. When set to take the syrup, it allows some of the molasses to run through, giving a harder and better jaggery. The use of this type of mould on a wide scale is to be advocated. In some places, the hot syrup is run on to mats and when set, is cut into slabs. In such cases, the mats must be protected from wind and dust and renewed frequently.

Fresh jaggery from the moulds is slightly moist and liable to collect dirt. It must be packed in clean trash or gunny and stored in a dry place.

It is better to grade the jaggery according to quality. As jaggery prepared in different parts of the State varies within wide limits, in colour, composition, shape and size of bits, it is difficult to work out a satisfactory standard of grading purposes. The Indian Institute of Sugar Technology has put up a system of grading based on colour and composition of jaggery. It would be in the interest of both producers and consumers to bring this system into use.

The composition of jaggery varies somewhat with the variety, the state of maturity of cane and other factors. But the main constituents[11] are cane sugars (60-85 per cent.), invert sugar (10-15 per cent.), moisture (3-6 per cent.) and ash (2-5 per cent.). All these are derived from the cane, except a portion of the ash which may have come from the clarifying agent used. Good quality jaggery is low in ash and moisture and high in sugar content.

Jaggery is an article of food which is peculiarly Indian. It is delightful and nourishing. It is an ingredient of our daily food. No feast is complete without a dish containing jaggery, and few rituals, social or religious, in which jaggery has not a recognised place. It is valued constituent of many *Unani* and *Ayurvedic* medicines. It is too important a commodity to be treated with neglect. We owe it to ourselves that we produce only the very best quality.

## III

## *BOORA* SUGAR

This is a type of sugar which finds a special place in the culinary art of our people and is used widely by sweetmeat

[11] Taken from *Gur Monograph* by S. C. Roy.

manufacturers. Everyone is familiar with the name *Kolar Boora* so called on account of its preparation by jaggery-makers of Goribidanur and Malur in Kolar District. *Boora* sugar has nearly the same composition as jaggery but contains somewhat less of moisture and reducing sugars. In its preparation, greater care is taken to filter and clarify the juice and the syrup is struck a little earlier than for jaggery, *i.e.*, at about 112-15° C. The hot syrup is rubbed down against the side of the pan with the *gorumane* until it cools down to the room temperature. The process of rubbing converts it into a light, non-granular powder with a pleasant and characteristic flavour. The colour of the product as ordinarily prepared is light brown to straw yellow, but it tends to become dark on storage, particularly if it is not prepared properly. When the moisture content is high and under humid conditions of storage, it deteriorates rapidly giving rise to a product of unpleasant odour and sour taste.

A superior quality of *boora* sugar with better keeping quality and sales appeal can be prepared by using activated carbon for clarification of the juice. The process is the same as for cream jaggery upto the point of obtaining the syrup. The syrup is struck at about 112-15° C. (which can be judged from the size of bubbles in the pan) and the hot pan with syrup in it is placed on a circular platform, 1½′ high, made by piling fresh bagasse in a circular heap. Four men with ladles (*gorumanes*) then stand at four corners and stir the syrup slowly, running the syrup against the side of the pan. This tends to cool the syrup uniformly and prevents the formation of big crystals. When the syrup begins to thicken, it is stirred more vigorously, the motion of the *gorumane* being so directed as to heap the cooling mass against the sides of the pan. When it becomes semi-solid, the men move round the pan briskly rubbing the mass vigorously in a rotary fashion, against the sides and bottom of the pan. In 8-10 minutes, this vigorous stirring and rubbing produces a fine, pulverised sugar, light and fluffy to the touch. The colour is cream yellow to brilliant white according to the concentration of the activated carbon used for clarification and the product has an appealing pleasant flavour. The process has been widely demonstarted on Government farms, and during fairs and exhibitions and the product has always found a ready sale.

*(To be continued)*

# RESEARCH NOTES

## Aphis on Trapa and its Control

*Trapa bispinosa,* otherwise called *Singhara* or water chestnut, is usually grown over a large area in Kashmir and Upper India. It is said that this forms the principal food in certain areas in those places where the natural factors like rainfall, etc., have not helped the agriculturists grow the other staple crops.

The trapa plants grown on the Agricultural Research Station, Hebbal, and the botanical plot of the Laboratory were severely infested by the aphis—*Rhopalosiphum nymphææ* L. The insect is dark brown to green in colour, having dark patches on the body surface, being slightly rotundiferous. It is sufficiently larger in size and when disturbed was observed to move for short distance on the surface of water. This aphis has been considered to be of worldwide distribution. Theobold has listed more than 30 host plants. In this are also included the three host plants, *Lemna* sp., *Nelumbium speciosum* and *Scirpus lacustris* recorded in India by Das. This seems to be the first record of this aphis observed on *Trapa bispinosa,* which may be included in the list of host plants. The damage caused by *Rhopalosiphun nymphææ* to trapa resulted in the crinking of the leaves, some of which showed a withered appearance. The insects were found in large numbers on the upper surface of the leaves, few only being present at the base of the leaf. Associated with the aphis were also present two coccinellid beetles—*Pullus nubilus* Muls. and *Pullus piescens* Gorh. These were in the pupal stage when control measures were adopted to check the damage by aphis. Preliminary trials in the laboratory with FOLIDOL E 605 and BHC 5% dust against this insect gave satisfactory results. The dust was slower in action. While FOLIDOL E 605 readily mixed with water when sprayed, the BHC dust formed a thin film on the surface of water on which it was dusted. FOLIDOL E 605 at 0·03% strength was sprayed, and the observations were made about 24 hours after treatment. It was found that the aphids were dead and floating on water. The coccinellid pupæ which were found on the upper surfaces of the leaves were collected 24 hours after the spray and kept for emergence of beetles. The water in the treated plots were drained about 24 hours after the chemical was applied and fresh-water was let in. There was no phytotoxic effect observed

due to the spray. The adult coccinellid beetles emerged out of pupæ sprayed with FOLIDOL E 605, 0·03%. No definite observations were made on the effect of the spray at the strength used on adult beetles. There was no re-building of the aphid population after the spray.

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*February* 18, 1955.

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# CORRESPONDENCE

## Some Preliminary Observations on the Leaf-Yellowing of Sugarcane in the V.C. Tract

DURING June 1955, a leaf-yellowing of sugarcane was observed throughout the V.C. Tract, Mandya District. Such an yellowing had been noticed in the previous years in the ratoon crop in isolated cases, but this was the first time that it was so widely spread and had assumed a serious status. Affected leaves exhibited either alternate streaks of yellow and green or uniform yellowish or pale white colour. The new sproutings, young and grown-up plants, and ratoon canes were all affected. The affected young plants were stunted in growth, grassy and with practically no stem or cane formation; even-

TABLE I

*Extent of Leaf-Yellowing Affection*

| Clump affection | | | | | Plant affection | | |
|---|---|---|---|---|---|---|---|
| Area, age of crop and locality | Date of observation | Total clumps | No. of clumps affected | Percentage | Total plants in affected clumps | No. of plants turned yellow | Percentage |
| 0–20 Ac. ½ month Hosali | 18–1–1956 | 780 | 4 | 0·5 | 16 | 11 | 68·7 |
| 0–10 Ac 3 months V.C. Farm | .. | 405 | 29 | 7·1 | 124 | 109 | 87·9 |
| 0–20 Ac. 3 months Komeralli | 20–1–1956 | 944 | 54 | 5·7 | 744 | 581 | 78·09 |
| 0–20 Ac. 4 months Lokasandra | 23–3–1956 | 740 | 2 | 0·27 | 9 | 9 | 100·0 |
| 0–20 Ac. 4 months Bansvadi-B | 23–3–1956 | 384 | 6 | 1·5 | 58 | 28 | 48·2 |
| 0–20 Ac. 8 months Ramanalli | 23–3–1956 | 584 | 6 | 1·02 | 24 | 24 | 100·0 |
| 0–20 Ac. 8 months Bansvadi-B | 23–3–1956 | 262 | 13 | 4·9 | 181 | 132 | 72·9 |
| 0–20 Ac. 4 months Komeralli | 20–1–1956 | 633 | 16 | 2·5 | 253 | 202 | 79·8 |

tually they dried up and died. The infected grown-up canes appeared sickly, with yellowish leaves and side tillers. Counts taken at random from the different age-groups of the crop (1½ to 8 months old) in the affected areas showed a 0·5% to 7·1% infestation of the clumps and 48·2% to 100% infestation of the plants in the infested clumps (Table I). None of the different varieties present on the V.C. Farm, *viz.*, I.C. 223, I.C. 203, I.C. 195, I.C. 215, C.O. 634, C.O. 417, C.O. 419, C.O. 631, H.M. 661, H.M. 320, showed immunity from the disease (Table II). Nor the type of soil—black, sandy, loamy—had any apparent effect.

TABLE II

*Percentage of Leaf-Yellowing Affection in the Different Varieties of Cane*

| Name of variety | Percentage of clump affection | | | Percentage of plant affection | | |
|---|---|---|---|---|---|---|
| | I Replication | II Replication | Average | I Replication | II Replication | Average |
| I.C. 223 .. | 6·2 | 5·4 | 5·8 | 95·2 | 81·5 | 88·35 |
| I.C. 203 .. | 4·1 | 15·3 | 9·7 | 77·7 | 94·2 | 85·9 |
| I.C. 195 .. | 20·4 | 5·5 | 12·9 | 76·3 | 59·5 | 67·9 |
| I.C. 215 .. | 12·7 | 13·6 | 13·4 | 89·5 | 100 | 94·7 |
| C.O. 634 .. | 1·7 | 4·7 | 3·2 | 33·3 | 100 | 66·6 |
| H.M. 661 .. | 1·4 | 3·2 | 2·3 | 100 | 62·5 | 81·2 |
| C.O. 417 .. | 9·67 | 16·0 | 12·8 | 86·1 | 77·5 | 81·8 |
| C.O. 419 .. | 7·92 | 5·0 | 6·4 | 90·9 | 100 | 95·4 |
| C.O. 631 .. | 1·04 | 6·3 | 3·6 | 100 | 89·7 | 94·8 |

The possible cause of the present yellowing of sugarcane leaves on an unprecedented scale is not yet known. The symptoms are no doubt of a complicated nature, combining those of a mosaic, virus and deficiency diseases. However, observation made so far in experimental plots, corroborated by general field observations, show that it is transmitted through setts. Yellowing symptoms, followed by stunted and grassy growth, invariably occur in young plants obtained from setts of diseased canes. But sometimes apparently healthy canes at a late stage put forth diseased side tillers and show up leaf-yellowing. In such cases no visible transmission agents have

come to light in spite of careful observations. Certain species of aphis, thrips, jassids and mealy bugs—types of insects which are well-known vectors of virus diseases of various crops in other parts of the world—are present both in the affected and healthy canes in the V.C. Tract, but preliminary transmission tests conducted with these insects have so far given only negative results. More trials are in progress.

In the meanwhile, as it is definitely known that leaf-yellowing is transmitted through setts, the sugarcane cultivators are advised to plant setts taken only from healthy canes and to destroy all diseased sproutings.

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## Observations on Crop Maturation

The following set is the third among a series of observations made by the writer in the latter part of 1954, *i.e.*, from September 1954 onwards on agricultural crops. Similar observations were made on a few vegetable crops grown by him in his compound out of sheer inquisitiveness. He is therefore much indebted to the Editorial Board of the *Mysore Agricultural Journal* for publishing these observations and thereby eliciting further information and comments from others who are similarly interested.

| Name of the crop | Date of the opening of flower | Date of maturation | Duration of time (in days) | Remarks |
|---|---|---|---|---|
| *Gossypium acuminatum* .. | 12—9—1954 | 31-10—1954 | 59 | Defective |
| do .. | 13—9—1954 | 10-11—1954 | 58 | dehiscence |
| do .. | 22—9—1954 | 30-11—1954 | 69 | |
| do .. | do | 1-12—1954 | 70 | |
| do .. | 30—9—1954 | 11-12—1954 | 72 | |
| *Gossypium peruvianum* .. | 3-10—1954 | 16-12—1954 | 74 | |
| do .. | 30-10—1954 | 5—1—1955 | 67 | |
| *Gossypium arboreum* .. | 30—9—1954 | 6-12—1954 | 67 | |
| do .. | 30—9—1954 | 11-12—1954 | 71 | |
| *Ricinis communis* (Castor) | 28—8—1954 | 4-10—1954 | 37 | var. (ಚಟ್ಟಿ ಹರಳು) |
| do .. | 1—9—1954 | 7-10—1954 | 36 | |
| do .. | 6—9—1954 | 15-10—1954 | 39 | |
| do .. | 8—9—1954 | 14-10—1954 | 35 | |
| do .. | 10—9—1954 | 12-10—1954 | 31 | |
| do .. | 13—9—1954 | 27-10—1954 | 44 | |
| do .. | 28-10—1954 | 12-12—1954 | 45 | |
| do .. | do | 18-12—1954 | 51 | |
| do .. | 16-11—1954 | 2—1—1955 | 37 | |
| *Dolichos lab lab* (Avare) .. | 22-10—1954 | 22-11—1954 | 31 | |
| do .. | 25-10—1954 | 24-11—1954 | 30 | |
| do .. | 27-10—1954 | 23-11—1954 | 27 | |
| do .. | 28-11—1954 | 25-11—1954 | 28 | |
| *Vigna catjæng* (Cowpea) | 17—9—1954 | 8-10—1954 | 22 | |
| do .. | 18—9—1954 | 9-10—1954 | 21 | |
| do .. | 20—9—1954 | do | 18 | |
| do .. | 21—9—1954 | do | 18 | |
| do .. | 5-10—1954 | 26-10—1954 | 21 | |
| do .. | 27-10—1954 | 18-11—1954 | 22 | |
| *Cajanus cajan* (Garden thogari) .. | 30—8—1954 | 13-10—1954 | 44 | |
| do .. | 31—8—1954 | 20-10—1954 | 51 | |
| *Lycopersicum esculentum* (Tomato) .. | 25—9—1954 | 6-11—1954 | 42 | |
| do .. | 15-10—1954 | 11-12—1954 | 57 | |
| do .. | 22-10—1954 | 8-12—1954 | 47 | |
| do .. | 27—9—1954 | 14-11—1954 | 47 | |

618, West Park Road, Malleswaram, Bangalore-3, *January* 6, 1955.

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